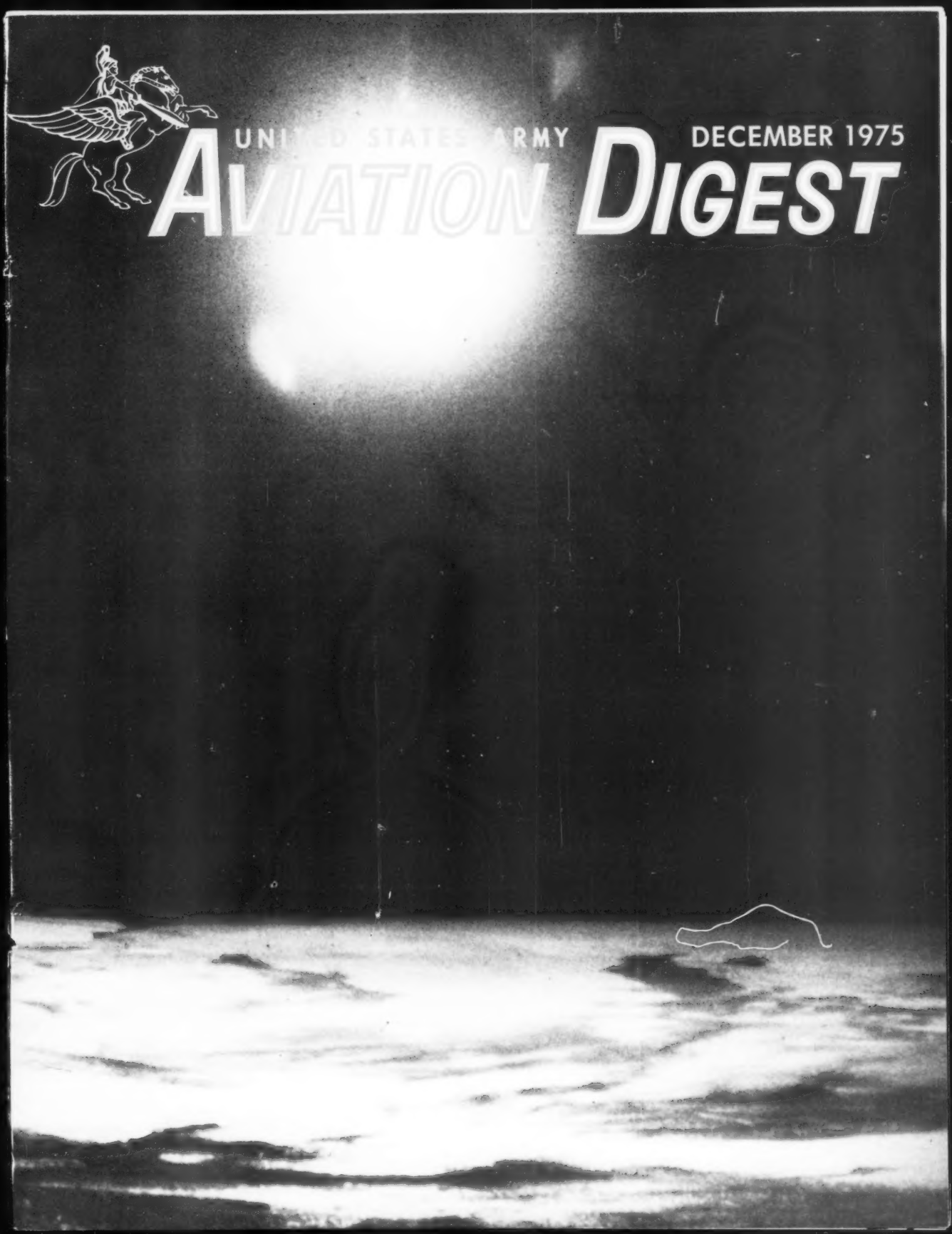
UNITED STATES ARMY
AVIATION DIGEST
DECEMBER 1975

UNITED STATES ARMY AVIATION DIGEST

DECEMBER 1975 VOLUME 21 NUMBER 12

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MG William J. Maddox Jr.
COMMANDER
U. S. ARMY AVIATION CENTER
A major activity of the
U. S. Army Training and Doctrine Command

COL Norman W. Paulson
COMMANDER
U. S. ARMY AGENCY FOR AVIATION SAFETY
A major activity of the
Inspector General and Auditor General
of the U. S. Army

Richard K. Tierney
EDITOR
U. S. ARMY AVIATION DIGEST

ABOUT THE COVER

A 2.75 inch illumination flare lights up the landscape and introduces the first of the *DIGEST's* two "After Sunset" issues. See page 8 for a story on the flare

The mission of the *U.S. ARMY AVIATION DIGEST* is to provide information of an operational or functional nature concerning safety and aircraft accident prevention, training, maintenance, operations, research and development, aviation medicine and other related data.

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Articles, photos, and items of interest on Army aviation are invited. Direct communication is authorized to: Editor, U.S. Army Aviation Digest, Fort Rucker, AL 36362.

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NIGHT HAWK TRAINING TEST

Part I: The Overview

CW2 David R. Heaton
Advanced Division
Department of Undergraduate
Flight Training
Deputy For Training
U. S. Army Aviation Center
Ft. Rucker

NIGHT FLYING is not new to Army aviation but experiences in the Republic of Vietnam and more recently the 1973 Mideast War clearly demonstrate the need for a more effective night flying training program.

Intelligence reports from the recent Mideast battlefield indicate that a percentage of weapons that will be encountered in a high threat environment are optically sighted and can be defeated by poor visibility, adverse weather and night operations. And, radar and sensor-guided type weapons can be defeated by different types of terrain flying, both day and night. As a result, Army aviation tactics employed in a high threat environment during daylight

NIGHT HAWK TRAINING TEST

hours also must be employed during the hours of darkness to give an around-the-clock capability.

During a summer conference in 1974 on increased tactical night training, Major General William J. Maddox Jr., commander, United States Army Aviation Center, provided guidance which resulted in the Night Hawk Training Test. The purpose of the test was to find out what UH-1 stagefield and tactical training maneuvers could be performed safely and successfully at night *without* the aid of night vision seeing devices or without the aid of any external lights on the aircraft.

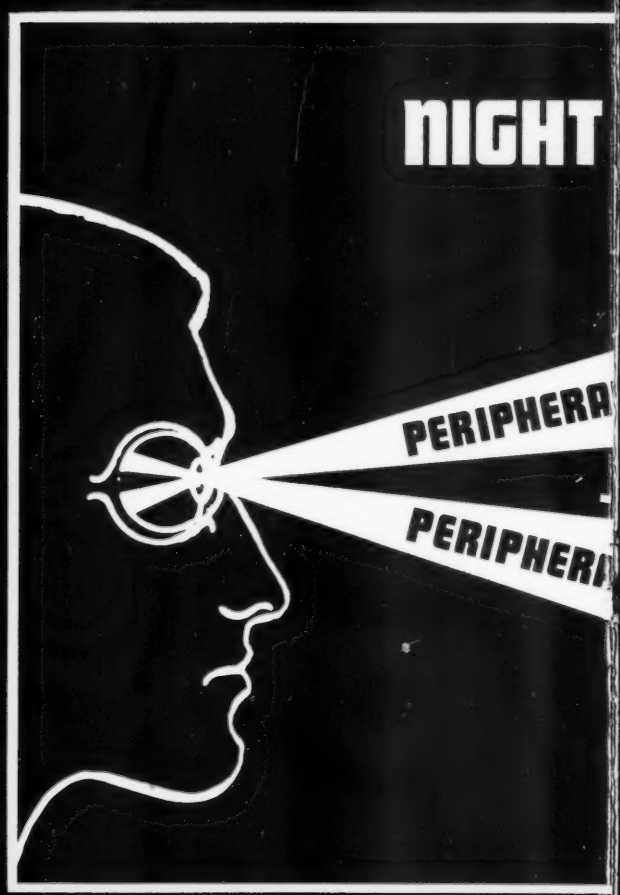
With this purpose in mind, Night Hawk was set up in three phases with Phase I starting on 4 November 1974.

Phase I was designed to determine the feasibility of night training in all UH-1 training maneuvers to include emergency procedures and to ascertain training requirements for the night qualification of instructor pilots (IPs) in these areas. Standardization instructor pilots (SIPs) from the Deputy for Standardization, the Department of Undergraduate Flight Training's Advanced Division and the Department of Graduate Flight Training, all from the Aviation Center, were selected to conduct the first phase. These SIPs would train themselves and develop methods of instruction to train future instructor pilots.

In order to monitor mental and physical stress on an aviator operating in a low ambient light environment without visual aid devices, technical observers from the U.S. Army Research Institute Field Unit and the U.S. Army Aeromedical Activity were present during each flight period.

Prior to the actual flying the participating pilots attended detailed and informative classes on night vision techniques, structure of the eye and limitations of the eye under low ambient light conditions. During these classes presented by the Aeromedical Activity, it was pointed out that the rod cells can respond to extremely low intensities of light, less than that of one-half moonlight. Millions of rod cells are distributed over the entire retina except the central area, macula, where only cone cells are located. Consequently, if a pilot looks directly at an object under such low light conditions he would miss it. The type vision that should be used under reduced lighting is off center or scotopic vision. By scanning off center the pilot can see the shape of objects and pick up visual information.

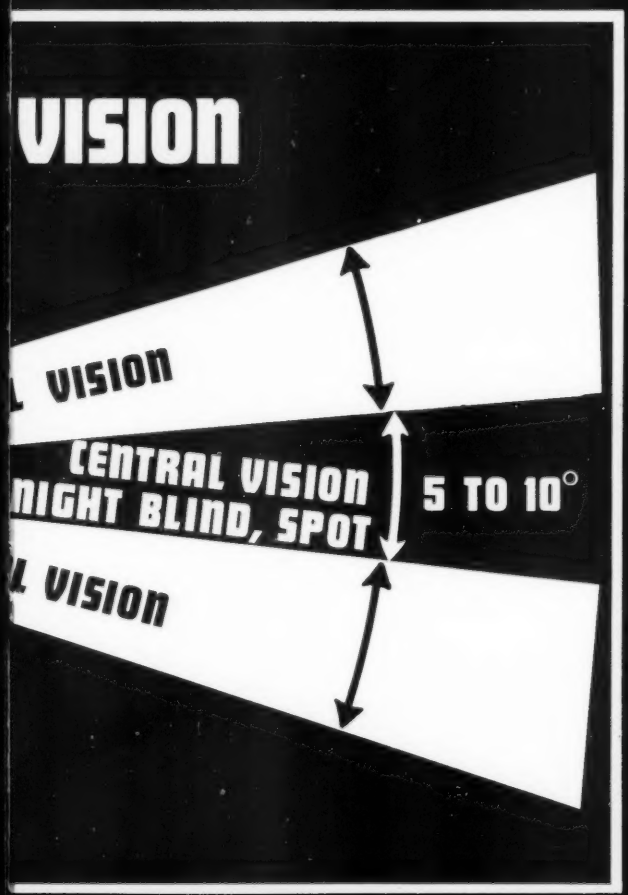
The first two flight periods during Phase I were in the daytime so the pilots could familiarize themselves with each other's techniques. During night flying, aircraft started out with full lighting—navigation lights on steady bright with landing and searchlight. Then the tests progressed to the point where the pilots were performing all maneuvers using only steady dim navigation lights. Some difficulties were experienced in the termination of maneuvers during the initial periods of the minimum lighted training. These problems usually were caused by



excessive rate of closure or misjudged pitchpull altitudes. At the end of each flight period a detailed debriefing was held when problems and possible solutions were thoroughly discussed. During these debriefings effective scan patterns and landing techniques were developed. At the end of Phase I the pilots could safely and successfully perform all the required maneuvers, regardless of aircraft lighting, stagefield lighting or available moonlight.

With the data obtained from Phase I, a detailed program of instruction was developed for Phase II which was held during the period 20 January through 13 February 1975.

Phase II of the Night Hawk Training Test was intended to night qualify one flight of the Department of Undergraduate Flight Training's Advanced Division instructor pilots (12 IPs) and provide data for future modification of the Rotary Wing Instructor Pilots Course and the local UH-1 Method of Instruction Course.



To see if the success of Phase I was due to the high experience level of the pilots, Phase II pilots were selected based on flight experience. The 12 selected had total flight time ranging from 650 to more than 3,000 hours. Instructor pilot time ranged from 4 hours to more than 2,000 hours.

As in Phase I, all pilots attended classes on eye structure and limitations presented by the Aeromedical Activity; also, a night vision eye test was administered to both Phase I and II pilots. After the completion of the eye test two pilots were issued glasses to improve their night vision. It should be noted that a person can have perfect 20/20 vision during the day but it can be less than 20/20 at night.

Aircraft lighting in Phase II also progressed from full lighting, navigation lights on steady bright with landing and searchlight, to steady dim only. In certain instances approaches were made without any aircraft lighting.

During the tactical operations away from the stagefield, landing zones (LZs) were located by using navigational aids located in Fort Rucker's tactics area of operation. Once the LZs were located, low level operations were performed. While performing these minimum lighted low level operations in and around the unlighted and uncontrolled landing zones, Flatiron, Fort Rucker's crash rescue detachment, was overhead in case its services were needed.

As the pilots' confidence and proficiency increased, little difficulty was experienced in performing the maneuvers without the aid of the landing or searchlight and regardless of available moonlight. This had been the case in Phase I.

A seminar was held at the completion of Phase II with all instructors and observers from both phases attending. During the seminar the proposed conduct of Phase III was developed. The recommendations were forwarded and approved and Phase III was scheduled for 5 to 29 May 1975.

Phase III's objective was to night qualify 16 student pilots and provide data for the conduct of additional night training in the Initial Entry Rotary Wing Program; Rotary Wing Instructor Pilot's Course and the local UH-1 Methods of Instruction Course.

With the objectives for Phase III established, 16 initial entry student pilots were then selected. Eight were commissioned officers and eight were warrant officer candidates. The only selection criteria was to use students who were going to be assigned within the United States so that followup action could be possible.

Again stagefield lighting was on a minimum and

Continued on page 14

As used on the OPTIC the infrared systems are entirely independent of visible light since the systems operate in the spectrum above the visible light level. A thermal image is produced by detection of heat differentials among various objects; the thermal representation on the crew scopes is in the form of the real-life object

OPTIC PNVS

Captain Robert D. Nelson
Engineering Flight Test Activity
Night Vision Laboratories
Ft. Belvoir, VA

WHAT IS AN OPTIC? That's an acronym for:

Observer's Target Acquisition System (OTAS)
Pilot's Night Vision System (PNVS)
Tactically
Integrated
Cobra

(You can see it on the AH-1 Huey-Cobra in the photograph above.)

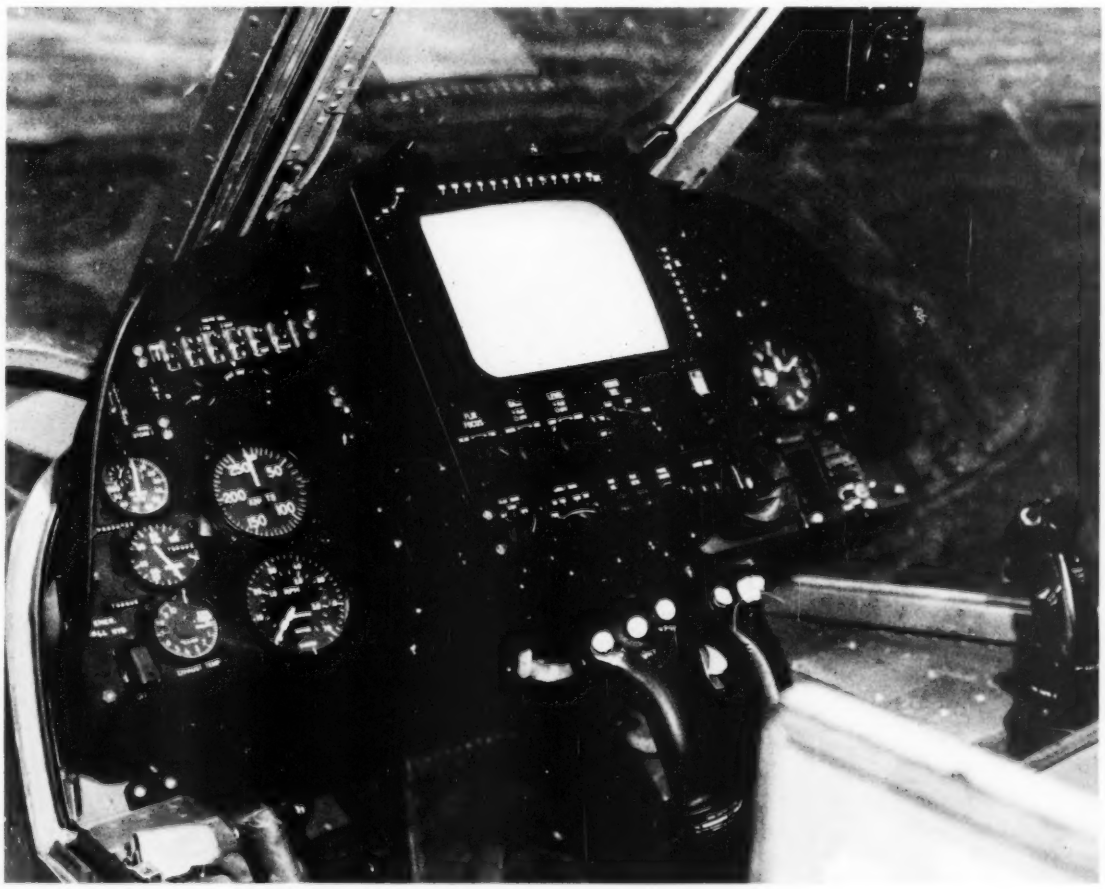
That's about all I knew about it in February 1974 when the engineers at the Night Vision Laboratory (NVL), Fort Belvoir, VA, started talking about finding a high-time Cobra jockey with night vision systems experience. Being the only aviator at NVL with that kind of experience, I knew I was in for another night vision project.

At that time, I'd been with the Night Vision Laboratory about 3 years and had flown an assortment of night vision systems including infrared systems, image intensification systems (including the AN/PVS-5 "CAV NAV" goggles) and several of the more exotic devices enabling a pilot to see at night. For the first time, however, OPTIC would provide both the gunner/navigator and the pilot with their separate systems. The gunner/navigator would have a FLIR (forward looking infrared) system (the OTAS) mounted at the XM-28 gun turret position. It was to be fully slewable, electrically operated and viewed on a 10-inch diagonal monitor (photo below).

The pilot would have another FLIR (the PNVS) mounted directly on the nose. He would have the option of viewing his system on another 10-inch monitor and controlling the turret with a thumb switch on the collective head, or viewing the system through a 1-inch HMD (helmet mounted display) and controlling the turret

Continued on page 16

AH-1 Cobra front seat station showing a closeup of the observer/gunner's panel mounted display



a lover's moon

or

a light in the night

for

army aviators

Describes how the Army aviator can capitalize on the various light levels of the moon during future missions in a high threat environment. Different moon phases are discussed and clarified. The author also tells of the predictability, years in advance, of the light level that will exist on a particular night

Rush R. Wicker

Education Specialist
Training Developments Department
Deputy for Developments
Fort Rucker

SINCE THE BEGINNING of time the moon has provided man a romantic background for wooing his lover. Consequently it is often referred to as a lover's moon. This connotation is most applicable during periods when the moon is radiating its greatest reflective illumination. During a new moon phase however, it tends to lose some of its romantic appeal and less emphasis is placed upon its romantic value.

Throughout the ages the moon also has played an important role in land and water navigation. Early seamen developed scientific means of determining their position by the angular measurements of the ship's position in relation to the altitude of the moon. Illumination was not a significant factor; however, the phase angle (e.g., new moon or full moon) *was* of significant value because visual observation was necessary to use the moon as a navigational aid.

Those who live along the seacoast are affected by the moon in a different manner in that its altitude (height of the moon above a given position) affects the level of the tide.

During recent years the moon has become increasingly important for space exploration and with the return to earth of *moon samples*, knowledge of its physical composition is no longer a secret. You might conclude that man has conquered the moon. Even though a wealth of information related to the moon is available, the average Army aviator is naive as to how he can use the illumination of the moon to help him to navigate at night.

In past conflicts the military value of the moon as associated with night operations has received only limited exploitation. We can anticipate that in future conflicts greater emphasis will be placed upon the conduct of night combat operations because of the advanced technology in air defense systems. The aviator can avoid detection and engagement by weapons that require visual acquisition by conducting operations in darkness which provides excellent concealment.

The capabilities of more sophisticated weaponry require that the helicopter be flown at extremely low altitudes which will prevent detection by electronic means. Whereas, formerly the darkness denied the enemy visual detection, radar possesses the capability to acquire targets during all meteorological conditions 24 hours a day.

To successfully accomplish a mission in a high threat environment, the Army aviator must be capable of conducting night terrain flight. This requires that he become knowledgeable concerning the moon. The romantic attraction which once was man's greatest concern for the moon must now become his light in the darkness. The first factor to be considered when planning a night combat operation is the moon phasing angle as it relates to hemispherical illumination.

Due to the systematic revolution of the moon in its orbit around the earth, it completes a cycle every 29 days 12 hours 44 minutes and 28 seconds. During the phase, various levels of ambient light are re-

flected. Low light will extend from a new moon to a crescent, which is described as the phase between new moon and first quarter. The time required to complete this phase is about 6 days.

Following a low light phase is a mid-light condition. The dividing line between the ambient light level that is available during mid-light and high light is difficult to distinguish but normally is identified when 60 percent of the moon is illuminated. Accurate predictions can be made years in advance of the light level that will exist on a particular night. Normally, the U.S. Air Force weather service supporting Army aviation units is qualified to forecast the phase angle and fraction of moon illumination for a given night.

It may appear from the discussion that the ambient light level during the 29 days of the phasing angle is predominantly a mid to high light condition. This would be desirable; however, many factors affect available light received from the moon. One of these factors is the moon altitude (the angle described from the observer's position to the moon). Maximum ambient light is received when the moon is directly overhead at the zenith position. Any altitude of the moon greater than this position will reduce the light level received at the observer's position.

Normally a greater portion of the night will be a low light condition, even though it may be a full moon. This is due to the changing altitude of the moon as it revolves around the earth. Because the ambient light level changes throughout the night, it would be beneficial to plan missions to take advantage of the altitude of the moon. To accomplish this, planners must have available information that provides moon altitude and ambient light level for every hour of the night. This data is not normally available through Army channels. To ensure that such information is available to the commander, it may be necessary to train an aviator in the techniques of computing the ambient light level based upon the moon altitude.

Another factor is the time the moon and sun set and rise. It is a normal assumption that when the sun goes down, the moon rises. This belief is far from being correct. How often have you looked up during daylight hours and seen the moon? When this condition exists, there won't be a moon that night. You may recall from past experiences where the first portion of a night flight was conducted in complete darkness, followed by a period of high ambient light conditions or visa versa. Both examples illustrate the fact that moonrise and moonset are important considerations in planning a night mission.

It is also important to know when the sun will set and rise (civil twilight). This consideration is significant in that effective ambient light is available after sunset until

Continued on page 19

BIG FLARE

With Rocket, To Go

Jack R. Still

Project Engineer
Illumination Rockets
2.75 Inch Rocket Project Manager's Office
Redstone Arsenal, AL

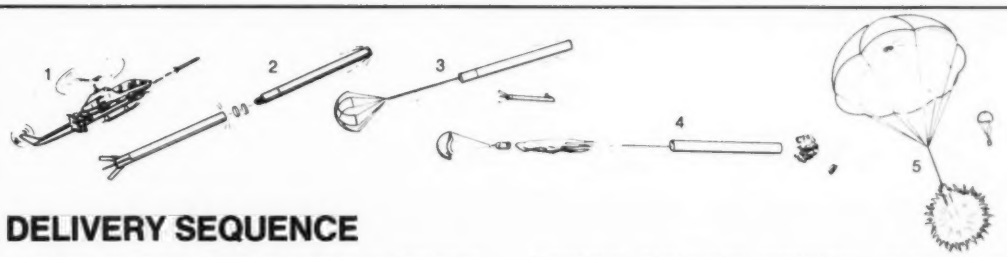
This article is a followup of a presentation given at the 18th Annual Tri-Service 2.75 Inch Rocket Symposium held last August at the U.S. Army Aviation Center, Ft. Rucker. See page 1, October 1975 *DIGEST*

A FLARE WARHEAD has been developed for the versatile 2.75 inch aircraft rocket. This warhead will give a helicopter unit the capability to carry and employ its own target illumination.

An obvious advantage of using rocket-deployed illumination is that the aircraft does not have to overfly the target and, thereby, become a prime target itself.

On a night mission, a pilot might fly nap-of-the-earch (NOE), pitch up, pickle off one or two flare rockets and then move to a new location while waiting for the flares to be ignited. The flare warheads begin to provide illumination approximately 13 seconds after launch.

The ideal altitude for flare ignition is 2,000 feet above ground level, which will allow the flare to provide 2 minutes of usable

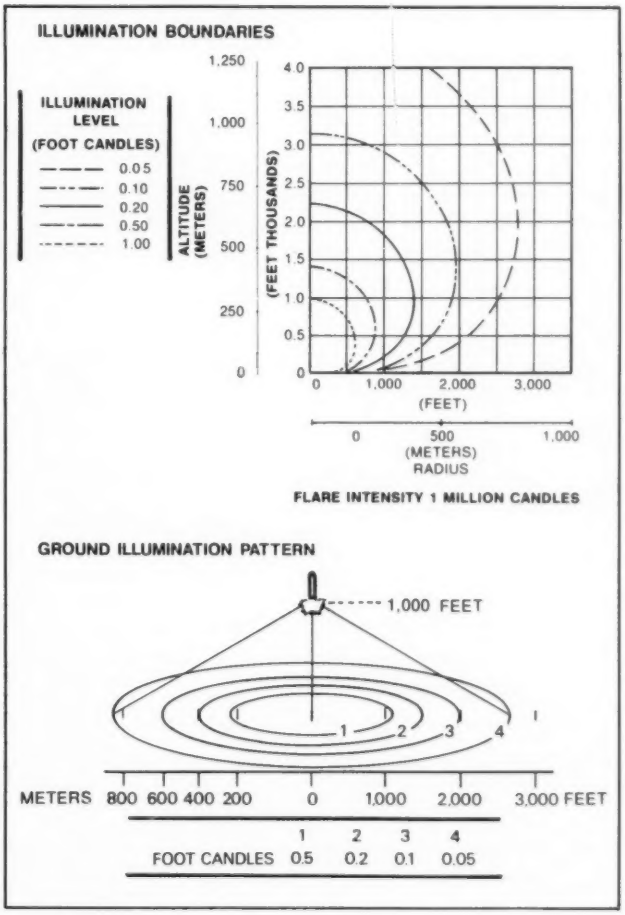


DELIVERY SEQUENCE

1. ARMING FUZE AND DELAY ASSEMBLY IS ACTIVATED BY MOTOR ACCELERATION
2. AFTER FIXED DELAY TIME, SPENT ROCKET MOTOR IS SEPARATED
3. DROGUE PARACHUTE DEPLOYS; INITIATES FIXED DELAY AND DECELERATES WARHEAD
4. DROGUE PARACHUTE SEPARATES, PILOT CHUTE ASSISTS MAIN PARACHUTE DEPLOYMENT, MAIN PARACHUTE OPENING FORCE ACTUATES FLARE IGNITION
5. FLARE DESCENDS SLOWLY DURING A 120 SECOND BURN TIME

DATA

Operational	
Light Output	1 million cd
Burn Time	120 sec
Parachute Descent Rate	3.96 m/sec (13 ft/sec)
Range	
With Present Fixed Time Delay	3,000 m (3,250.0 yd)
With Slight Modification	Up to 5,000 m (5,416.6 yd)
Future Version	Cockpit Settable 2,000 to 6,000 m
Physical Dimensions (Excluding Rocket Motor)	
Length	72.7 cm (28.62 in.)
Diameter	69.85 mm (2.75 in.)
Weight	4.9 kg (10.8 lb)



illumination. Nominal range of the present warhead design (XM-257) is 3 kilometers. It is effective when fired from a hover or using running fire.

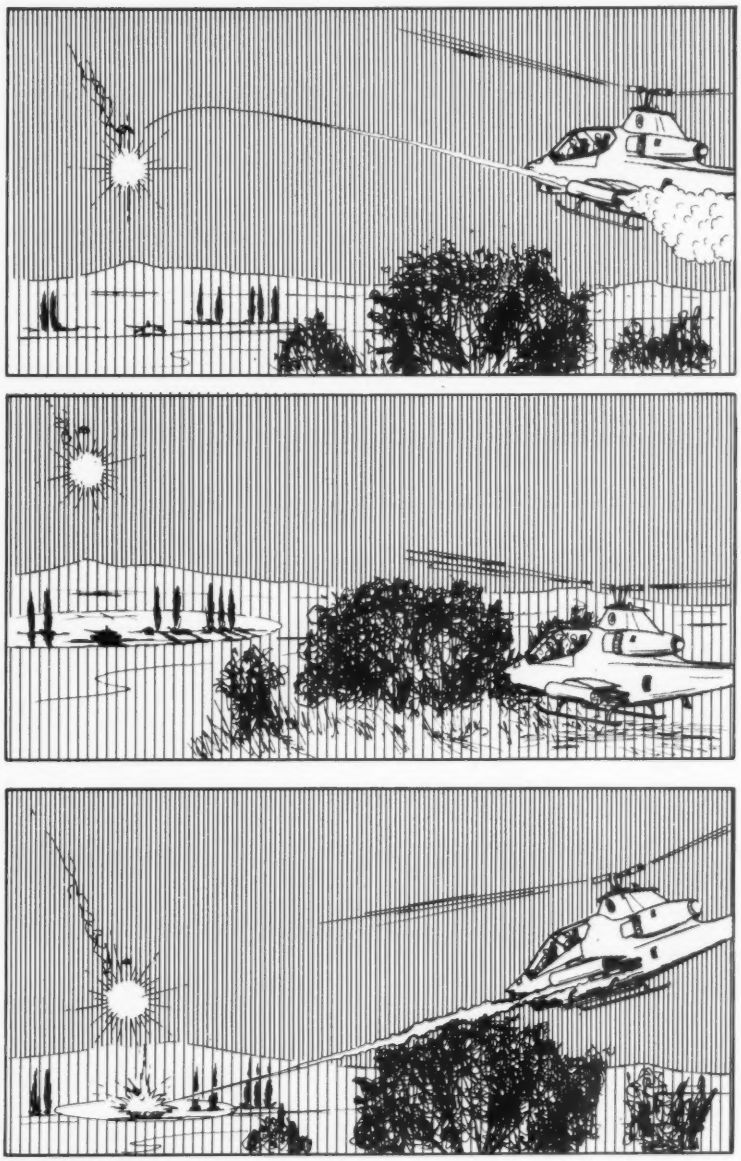
The XM-257 warhead is the result of a task in which the Land Warfare Laboratory (LWL) at Aberdeen, MD, and the Thiokol Corporation worked together to develop a standoff means of illu-

mination to be used in Southeast Asia. Ninety-five of the warheads were shipped to the Republic of Vietnam.

Reports received from the user in Vietnam indicated they were ideal for a helicopter unit to provide its own illumination without having to fly over the target. At about this time Vietnam operations were deescalated and the task lost momentum.

In 1974, the 2.75 Inch Rocket Project Management Office (PMO) initiated procurement of a number of flare warheads for testing and for use in night tests of air-launched TOW (tube-launched, optically-tracked, wire-guided) missiles. In 1975, numerous firing exercises were conducted at Ft. Hood, TX, Ft. Knox, KY, Ft. Campbell, KY, and Ft. Rucker, AL. The firings were witnessed by a broad spectrum of observers ranging from the chief of staff of the U.S. Army to youthful members of Army families. The Ft. Hood tests included the successful use of XM-257 rocket warheads by the 6th Cavalry Brigade (Air Combat) to illuminate targets for air-launched TOW missiles.

The response from Army officers who witnessed the flares in action was enthusiastic and resulted in a current action by the 2.75 Inch Rocket PMO to obtain a sufficient number of XM-257 warheads to satisfy near-term training requirements.



When the XM-257 rocket is fired, various functions occur in sequence. Rocket acceleration permits the fuze to arm, and deceleration at motor burnout actuates the fuze which initiates a 9-second pyrotechnic delay. At the end of the delay period, the fuze charge separates the warhead from the motor. A deflection plate attached to the motor forces it away from the warhead to prevent possible interference with the parachute.

After warhead/motor separation, a drogue chute deploys from the warhead which slows it down and initiates a 2-second delay. At the end of the delay period, a pilot chute is deployed which pulls the main chute out of the warhead.

The opening force of the main chute pulls a lanyard which cocks and releases a firing pin. The firing pin initiates a pyrotechnic train which blows the nose cap off the warhead and ignites the candle. The flare descends at about 13 feet per second and provides in excess of 1 million candle power of illumination. At an altitude of 2,000 feet (610 meters) the flare will illuminate a circular area 1 mile in diameter.

The project manager for the 2.75 inch rocket system plans to optimize the flare warhead. The optimized warhead will utilize a cockpit-settable fuze which will allow the pilot to select the range at which he wants the flare to be ignited. The maximum range of this optimized warhead will be significantly greater than that of the current non-optimized warhead.

VIEWS FROM READERS

Sir:

The article, "Aviation Tool Control Program," in the July 1975 ***AVIATION DIGEST*** was both well documented and informative. I need the FSNs and/or a method of procuring the toolboxes shown in figure 3, page 18.

The toolboxes would greatly enhance our maintenance section in many areas, i.e., monthly tool inventories and FOD damage due to misplaced tools.

CW2 Joe E. Tubbs
Safety Officer
Army Security Agency Field Station
Augsburg

• The *DIGEST* received the following response from the Army Transportation School in reply to Mr. Tubbs' letter:

At the present time, the Army does not have an established system for ordering the toolboxes depicted in figure 3, page 18, of the July 1975 issue of *AVIATION DIGEST*. As pointed out in the article, the toolboxes in the aforementioned figure are Navy toolboxes and are a part of their tool control program.

The U. S. Army Transportation School is attempting to review the Navy and Air Force tool control programs and extract some of the pertinent aspects and apply them to the Army's maintenance system. Going along with this concept, the Transportation School has reconfigured some of the toolboxes in the existing Army inventory and is planning to forward the tools to selected units for a field evaluation to ascertain what problems are foreseen in the field environment. After the input from the field study is received, the information will be forwarded to the U.S. Army Aviation Systems Command (St. Louis, MO) for fielding procedures.

We appreciate your support of the tool program in further substantiating the need for this type system.

[See "Views From Readers" in the November *DIGEST* for an additional letter regarding tool programs. Ed.]

Sir:

The U. S. Army Environmental Hygiene Agency will present the Seventh Annual "Military Hearing Conservation Workshop" for Department of the Army personnel during the period 12-16 Jan 1976. . . . It is requested that the attached . . . be printed in the ***AVIATION DIGEST***:

. . . The overall objective of the course is to provide information to personnel responsible for the implementation and maintenance of hearing conservation programs. The course outline covers the following areas of instruction: physics of sound; anatomy and physiology of the hearing mechanism; physiological effects of noise; noise measurement and analysis; hearing protective devices including practice in fitting earplugs; engineering control of noise; audiometric techniques including practice in performing pure tone air conduction tests; record-keeping; interpretation of audiograms; and calibration and maintenance of audiometers; noise hazards in voice communication systems; aural rehabilitation; variables in noise-induced hearing loss; and procedures for establishing an effective health education program.

LTC Manmohan V. Ranadive, M.D.
Director, Occupational Health
U.S. Army Environmental Hygiene Agency
Aberdeen Proving Ground, MD 21010

Sir:

We of the Aviation Detachment, Berlin Brigade, offer a not so original prayer to your magazine and all aviation personnel who read it. It is our hope that it will, in some small way, further our mutual goal of zero accidents. As the commander of the detachment, I feel so strongly that the message imparted by this prayer is beneficial that I have had it posted in my operations.

Our safety director, who art at Ft. Rucker,
Hallowed by thy goals.
Thy aims be met to the specifications set in the field
As they are in theory.
Take from us this day our annual quota and forgive us our errors as we continually strive to eliminate them.
Lead us not into unprofessionalism and deliver us from complacency, for zero accidents is the purpose, the pursuit, and the glory. Amen . . .

CPT William M. Durbin, U.S. Army, Berlin
Major Alexander Woods Jr.
Commander
Aviation Detachment, Berlin Brigade

Sir:

I would like to see the ***DIGEST*** occasionally publish an aviation safety article directed toward its "off-duty aviators," the members of the many Army flying clubs found throughout CONUS and overseas.

Since the mission of the ***DIGEST*** is "to provide information . . . concerning safety and aircraft accident prevention . . . and other related data," I would think that the many Army personnel, active and retired military, dependent and civilian, who fly with these clubs would provide both a readership and a source of occasional articles. In many cases, these club pilots share facilities, real estate and local airspace with Army aviation units and must contend with some of the same problems as the professional aviators.

Here at Redstone Arsenal, we have a relatively small flying club which, nevertheless, exposes personnel to more than 300 hours of flying time per month. Many of the articles appearing in the ***DIGEST*** over the past years . . . had application to our own flying. The two articles in the September issue by Patsy

Continued on page 27

6th Cav Night Operations

CW3 Joseph R. Donahue
NOE/AH-1 Cobra
Instructor Pilot

Major Moses Erkins
Commander A Troop
4th Squadron, 9th Cavalry

CW2 Ottis L. Morgan
Gunnery
Instructor Pilot

CONTEMPORARY military leaders have concluded that aviation units must be able to perform their missions under varying visibility conditions, particularly during hours of darkness and/or in smoke, fog or haze conditions.

Helicopter survivability on a mid intensity high threat battlefield will necessitate that Army aviators be confident, as well as proficient, in the techniques of night tactical flying and firing.

The challenge is to develop training programs which enable aviation units to master problems associated with night tactical operations. Alpha Troop, 4th Squadron, 9th Cavalry, 6th Cavalry Brigade (Air Combat), Fort Hood, TX, accepted the challenge and aggressively engaged in night operations designed to sharpen proficiency.

During a 2-week period in July 1975 Alpha Troop adopted a reverse training cycle. Normal duty hours during this cycle were from 2000 hours until 0500 hours daily. The troops and aviators were not subjected to a controlled environment or special diet; however, when a total reverse cycle is the standard, everyone in the unit, regardless of job, becomes involved. In addition to aviators, clerks, ammunition handlers, POL (petroleum, oils and lubricants) specialists, drivers, etc., must perform their "normal" tasks after sunset.

The prime objective of this training was to sharpen the unit's level of proficiency to the point where it could effectively perform any mission—during the hours of darkness—that would be tasked to an air cavalry troop during the daytime.

Flight training was phased to ensure that the aviators developed a steady progression of ability and confidence. During the first week, classes were conducted nightly from 2130 to 2230 hours to orient the aviators on the techniques of night operations. Subjects included techniques and hazards to night flight; night navigation and operations; night insertions and extractions; fire support for the attack; and convoy covering techniques.

Following classroom instruction, the aviators received a mission briefing, planned their flights and moved to field sites to put the instructions they had just received into practice. This flight training was initially non-tactical, and a more experienced aviator was paired with a less experienced one throughout the training cycle.

The aviators were required to fly three different routes over varying terrain, at an altitude of 200 feet or less. Landing zones were provided on each route and practice approaches to a "T" or "Y" were conducted. Training progressed throughout the week to different levels of difficulty as proficiency increased.

On the weekend, at night, the unit moved to Camp Bullis, TX, 150 miles south of Fort Hood, its parent organization. During this phase of training, all night operations were tactical and included aero scout reconnaissance, guard missions, area security missions and night insertions/extractions by the reconnaissance platoon. While at Camp Bullis, the operational altitude was 50 feet or less. Ground vehicles were used to simulate enemy activity. The aero scouts were able to detect stationary targets at 200 meters and to detect moving targets at 500 meters. The aviators used only terrain analysis for navigation and pinpointed their location to within 100 meters.

Night tactical firing was conducted at Fort Hood by the Aero Weapons Platoon. During night firing, communication and coordination between the pilot and copilot were determined to be the major critical factors for achieving successful target engagements. For example, during tactical flying to the firing positions, the copilot was responsible for monitoring the aircraft's location in preparation for target acquisition and firing.

Once an aircraft was in position, and unmasked, the copilot was responsible for monitoring engine torque, aircraft attitude and altitude during firing. Additionally, the copilot was especially attentive for any indication that the pilot was developing vertigo or target fixation and was prepared to take corrective actions.

Initially the pilots exhibited a tendency to gain altitude just prior to firing, or lose contact with ground reference points, which caused drifting. This tendency diminished as the pilots participated in more firing exercises and minimized control inputs during all phases of firing.

Two types of illumination—tank-mounted xenon searchlights and 4.2 inch mortar flares—were used for target illumination. Slight difficulties were encountered while employing the tank-mounted searchlight. If the beam of the searchlight was greater than 20 degrees from the azimuth of attack, intermingling light and shadow made target acquisition difficult. The use of mortar flare illumination, on the other hand, produced no significant problems in target acquisition.

Although Alpha Troop did not discover simple solutions to night tactical flying and firing problems, the experience gained by the aviators provides a basic level of understanding, as well as proficiency. This will enable the 6th Cavalry to use darkness to full advantage, rather than being handicapped after sunset.

Helicopter Rotor Blade Deicer Sought

THE U.S. ARMY is looking at methods to keep its helicopters warm during those long, cold, winter nights—or under any icing conditions.

The Eustis Directorate, U.S. Army Air Mobility Research and Development Laboratory (AMRDL), Ft. Eustis, VA, recently awarded Mechanics Research Inc., Los Angeles, CA, a $60,500 contract to study the use of a microwave deicer, similar to a household microwave oven, for helicopter rotor blades.

Gene A. Birocco, project engineer with AMRDL's Eustis Directorate, noted that Army helicopters presently are not able to fly under icing conditions, thereby limiting helicopter mission capability. In an effort to enable its helicopters to operate in all weather conditions, the Army is investigating several concepts for rotor blade protection. The microwave deicer concept appears to be what the Army is looking for; that is, lightweight, low electrical power requirements and low cost.

If the Army adopts the microwave concept, this is how it will work to keep the ice off the helicopters: the generated microwave electromagnetic waves would be directed out the length of the rotor blade and converted to heat in the ice at the bond interface between the ice and rotor blade, thus permitting the ice to be shed due to centrifugal forces caused by the blade rotation.

The contract work will include analyzing the feasibility of such a technique and defining some of the unknowns, such as cost, system weight and power requirements.

Contract specialist for the project is C. McCannless, Eustis Directorate.

Art by
SP5 Jeoffery Hoppe

ICAS TEST

THE COLD WEATHER phase of the Improved Cobra Armament System (ICAS) test has been completed by the Armament Systems Test Branch, U.S. Army Aviation Test Board (USAAVNTED).

Conducted at Fort Drum, New York, the test was designed to allow evaluation of the tube-launched, optically-tracked, wire-guided (TOW) missile system, which is mounted on the YAH-1Q aircraft, in a weather environment comparable to that found in middle Europe. In addition to problems in basic hardware operation, the test team was to investigate human factors and safety aspects of TOW missile system (TMS) operation in snow and sub-freezing temperatures. One of the areas of major interest and concern throughout the test was the proper

Continued from page 3

aircraft lighting progressed from navigation lights on steady bright with landing and searchlight to steady dim navigation lights only. In addition to night qualifying these students in the minimum lighted environment, their performance levels and minimum training time requirements were closely monitored to provide data for the future modification of the Initial Entry Rotary Wing Course and graduate courses at the Aviation Center. The plan was that students selected for Phase III would not be rushed during their training. So, 20 hours were allocated to achieve proficiency in these selected maneuvers:

- Night Approach
- Night Takeoff
- Running Landings/Hydraulic Off Maneuvers
- Standard and Low Level Autorotations
- Pinnacle and Landing Zone Operations
- Low Level Flight and Navigation
- External Load Operations

The pilots' confidence and proficiency increased as it had in the previous phases and all were able to safely and successfully perform all maneuvers. This was demonstrated by the students passing their end-of-stage checkride administered during the last flight period.

Phase III was a successful ending to the Night Hawk Training Test. Flying 596 accident-free flight hours in a minimum lighted environment confirmed that a majority of the UH-1 initial entry transition and tactical training maneuvers could be performed by highly qualified aviators and initial entry students during the hours of darkness.

As a result of all phases of the test it was recommended that the following maneuvers be approved and implemented in the night portion of the UH-1 night transition phase of the Initial Entry Rotary Wing Program; the local UH-1 Methods of Instruction Course and the Rotary Wing Instructor Pilot's Course:

- Night Takeoff
- Night Approach
- Running Landings/Hydraulics Off
- Low Level Autorotations
- Standard Autorotations
- Pinnacle Operations
- Landing Zone Operations
- Slope Operations
- External Load Operations

Under the current initial entry program the only maneuvers taught during the night Initial Entry UH-1 Transition Course are the takeoff and ap-

functioning and operation of the two sighting systems, the telescopic sight unit (TSU) and helmet sight system (HSS).

The ICAS copilot/gunner uses a stabilized TSU to aim at the target for missile launch and to track the target during missile flight. Inflight corrections are sent to the missile through the wire which unreels from the missile as it is guided along the path to the aiming point. The TSU uses an optics magnification of 2.5 power during target acquisition and 12 power for tracking. After missile launch, the aircraft can be maneuvered to 110 degrees right or left azimuth and +30 degrees/-60 degrees elevation during missile flight to the target. The TSU can also be used by the copilot/gunner for target acquisition/tracking during engagement of targets with the aircraft turret weapons.

The HSS allows either the pilot or copilot/gunner to aim the turret weapons by use of a sight reticle mounted in front of the user's right eye on the standard SPH-4 protective helmet. The helmet sight system also incorporates a "slaving capability" which allows the pilot to automatically position the TSU reticle to the same target on which he is sighting with his helmet sight reticle. This feature allows immediate and positive identification of the target by the copilot/gunner.

During the 3-week test, the YAH-1Q was flown 13.0 hours during which five TOW missiles were launched. Also, the M28A1E1 turret subsystem was used to fire 500 rounds of 40 mm and 10,000 rounds of 7.62 mm ammunition to evaluate weapons compatibility with both sight systems and to gather hit data to determine weapon effectiveness. To augment data acquisition, five external mounts for high speed motion picture cameras were placed on the YAH-1Q. Another purpose of the flights and firings was to gather data on target acquisition and tracking in reduced visibility caused by visible moisture in the air. Depending on ambient temperature, this moisture took the form of snow, rain or fog. In addition to the subjective evaluation by the project pilots who recorded their personal observations, a motion picture camera mounted internally to the TSU was used to photograph the targets as seen through the sighting optics. This data will be analyzed to determine the effects of reduced visibility on target acquisition and tracking.

The test was completed on schedule experiencing almost optimum test conditions. Temperatures ranged from +65 degrees F. to -11 degrees F. with a mean maximum to +31 degrees F. and mean minimum of +14 degrees F. Precipitation varied from very light snow flurries to 15 inches of snow in a 6-hour period. The test information obtained will be reviewed and analyzed for inclusion in the formal test report.

proach and the standard autorotations using the landing and searchlights.

The advanced phase of the present Initial Entry Rotary Wing Program is 10 weeks 65 hours. Of this 65 hours, 15 are devoted to night training. Due to the success of the Night Hawk Training Test and the increased emphasis on night training the new Optimum Initial Entry Program scheduled for implementation in the near future will contain 34.5 hours of night training in the advanced phase. This is an important step in the right direction if Army aviation is to attain an around-the-clock operating capability.

Improving night flying capability can be done through proper training in areas that seem insignificant but can greatly affect capability. These deal with areas such as light discipline. Not only should pilots be briefed on this subject but all personnel also should be taught good light discipline especially when operating near aircraft.

The care of windshields on aircraft and ground vehicles is important when operating in a minimum lighted environment. When vehicles and aircraft are not in use, covers should be placed on the windshields to prevent damage from blowing debris. This is especially true of vehicles and aircraft parked near hover taxiways for helicopters. Also the habit of filling out a dash 12 or 13 and then throwing the logbook on top of the instrument panel of a UH-1 should be stopped. This damages the windshield and is a common practice among both aviators and maintenance men.

Another area of importance is the use of off center visual scanning. This is the type of vision that should be used under low ambient light conditions when no night vision devices are available. When used correctly this type vision greatly increases the effectiveness of personnel operating in a low light environment.

Information regarding night rotary wing operations can be found in TC 1-28, "Rotary Wing Night Flight," which was revised after the completion of the Night Hawk Training Test.

In order to be successful in a combat environment, all personnel must have confidence in themselves and their equipment. Now is the time to develop training programs to give Army aviators the confidence they need to operate in the high threat environment—*around-the-clock!*

Next month CW2 Douglas Joyce's article, "Night Hawk Training Test, Part II," will deal with details of flight techniques and problems encountered.

OPTIC PNVS

Continued from page 5

with a head tracker assembly similar to the "Q" model Cobra (see photo, page 16). The PNVS turret would have slew limits of 90 degrees azimuth left and right and ± 23 degrees elevation. Experiments had been conducted with HMD and PMD (panel mounted display) before with less than satisfactory results, but for the first time the pilot's system would display various symbology to include: attitude information via an artificial horizon, radar altimeter readout, aircraft heading, airspeed and, most important, line-of-sight symbology (which can be simply put as an "impact point" on the display).

The OTAS would be mounted in a fully gimbeled turret capable of slewing 180 degrees in azimuth in either direction, 80 degrees down and 30 degrees up. It would have two fields of view (FOV)—a wide FOV for search and a narrow FOV for recognition. Also in the turret would be a day TV system, and a laser tracker and rangefinder/designator with a digital readout on the gunner/navigator monitor.

All of this information was laid out to me in the groundwork I did with the contractor at Dallas, TX, during the first half of 1974.

After 2 weeks of system ground school and several ground runups of the system, I made the initial system check flight on 13 July 1974. There followed a month at Dallas' Love Field shaking the system out and teaching myself how to fly off an HMD. As I said, I had experience with night vision systems but nothing really could have prepared me for flying off an HMD.

Key to Acronyms	
OTAS	Observer's Target Acquisition System
PNVS	Pilot's Night Vision System
NVL	Night Vision Laboratories
FLIR	forward looking infrared
HMD	helmet mounted device
FOV	field of view
PMD	panel mounted display
CDEC	Combat Developments Experimentation Command
AAH	advanced attack helicopter
NOE	nap-of-the-earth

One of the beauties of an infrared system is that it is totally independent of visible light so that effective training can be conducted in daytime for safety. The infrared system operates in the spectrum above the visible light level giving a thermal image by detecting the heat differential between objects. Foremost in my mind while I was learning the intricacies of flying this system was the thought that soon I would be an instructor for other system pilots! The OPTIC aircraft was to be the protagonist in the Combat Developments Experimentation Command (CDEC) experiment No. 43.7 phase IIa, Attack Helicopter Clear Night Defense, with the objective of validating a night vision requirement for the advanced attack helicopter (AAH). I not only had to teach myself to fly this new system but also devise a syllabus of instruction to train others.

In late August 1974, after a month of testing at Fort A.P. Hill, VA, we delivered the OPTIC to the

Pilot using the HMD. The author wears a form fit helmet which is a prerequisite for use of the helmet mounted display

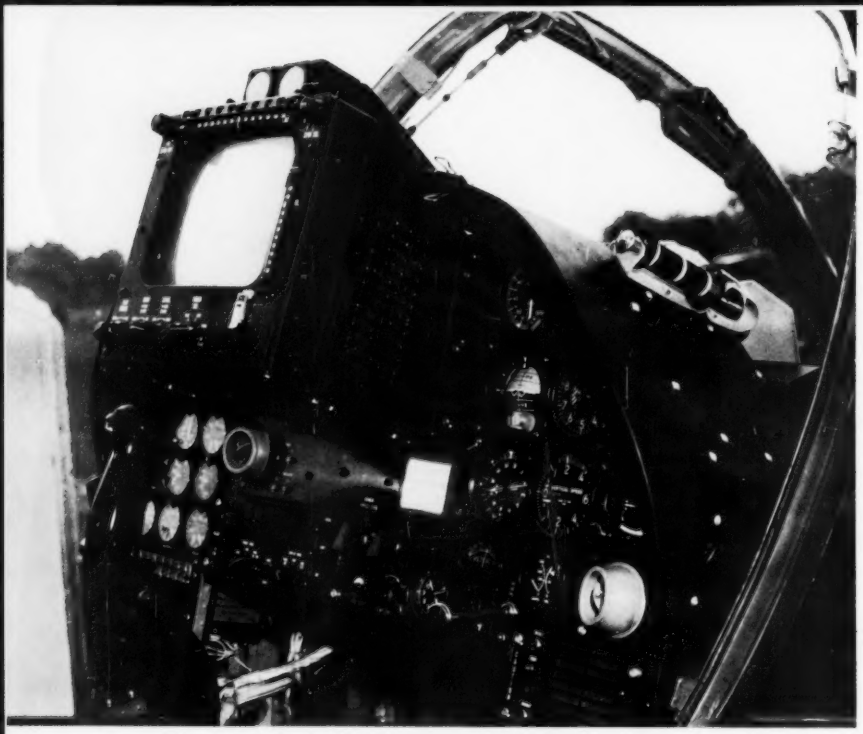
The PNVS sensor on the nose of the AH-1 Cobra and the OTAS sensor in the gun turret position give the helicopter an eerie, robot-like appearance

West Coast. Upon arrival at Hunter Liggett, CA, I immediately started training the pilots from the CDEC "Owl Team" on the OPTIC systems (see *DIGEST*, March 1974 issue). Each member of the "Owl Team" had received thermal imagery training and familiarization with the night vision goggles at NVL earlier in the year. In addition, with all the eyeball night work they had done, they were able students. It should also be noted that every "Owl Team" member had served in a Cobra unit in the Republic of Vietnam and had extensive night nap-of-the-earth (NOE) experience.

The training began with daytime flights incorporating a light sealing "bag" covering the pilot's station and progressed to night flights as the student became more confident with the system. Once trained, we (I had been included as a participant) started the experiment in October and completed it in late December 1974.

In all, we logged about 250 hours of system time during the experiment and participated in trials designed to test the capabilities of both the OTAS and PNVS. The trials were all geared to the night NOE environment and were as realistic as safety would permit. All target detection trials were initiated from a masked target position and included a "bob-up" maneuver to start a 2-minute search period. The target detection trials were run in tandem with a "Q" model Cobra with and without flare illumination to determine its night detection capability. The OTAS proved to be far superior under all light conditions. In fact, the OTAS could detect and recognize targets at ranges far exceeding expectations, surprising almost everyone involved.

Unfortunately, due to weather and time restraints, we had to terminate the experiment before the pilotage portion could be com-



Pilot's panel mounted display. Those involved in the experiment recommend the pilot be in the forward seat and use the helmet display

pleted. We definitely validated a need for an observer's system such as the OTAS but we will have to wait for the results of CDEC experiment 43.7 phase IIb scheduled for last October to validate the need for the PNVS in the AAH.

During the course of experiment 43.7 IIa we married the technical aspect of the night vision systems with the doctrine espoused by the CDEC Owl Team and came up with several strong prerequisites for any future night systems flying endeavors by Army aviators:

- The pilots involved should be experienced enough in the primary aircraft that pilotage is second nature allowing full concentration on "flying" the system.
- Night flying in a tactical environment should be accomplished by pilots dedicated solely to night flying and operating on a completely inverted schedule. This means living apart from day flying crews to effectively accomplish crew rest and even having their own mess hours.
- Team concept: The pilot and gunner/navigator of a night flying crew should train together and fly tactical missions together. In the night NOE environment you cannot have two separate people flying one aircraft; you must have a team, each man relying on the other's ability and judgment completely.
- Training cycle: Each night vision systems aviator should go through a standardized training cycle—first, daytime NOE qualification—second, night eyeball NOE training—third, night vision goggle training—last, receive advanced systems training.
- All of us involved in flying the experiment recommended to the AAH Project Manager that the pilot in any future attack helicopter intended for night operations be placed in the forward position and that he have a PNVS type system utilizing a helmet mounted display.

I might add the comment that the portion of the last recommendation concerning the HMD is based almost entirely on subjective data. Every pilot I've trained on the PNVS has favored the HMD over the PMD exclusively. There is little quantitative data to support this opinion but I feel it is valid for several reasons:

- The HMD/head tracker configuration allows "positive" control of the system giving the pilot a feeling of actually viewing what the system sees rather than looking straight ahead at a panel display depicting what is left, right or ahead of his aircraft.
- The ability to maintain night adaption in the unaided eye giving the pilot a basic backup should the system fail.
- The HMD/head tracker configuration allows easy incorporation of pilot directed flex weaponry.

I assisted in the training of Fort Knox 7/1 Air Cavalry aviators on the OPTIC aircraft who were to participate in CDEC experiment 43.7 phase IIb.

In this issue the article "Night Hawk Training Test" (page 1) describes the developments at the Aviation Center to train aviators to fly after sunset without aids. This, coupled with the systems we are developing at NVL can make the dark secure—instead of threatening.

The author is fixed and rotary wing qualified with in excess of 3,500 flight hours. He acquired 2,500 hours during two tours in Vietnam. The total also includes 800 hours night and 700 of this on various night vision systems experiments. Captain Nelson is currently TDY at Hunter-Ligget and upon completion of the testing he will be attending the Armor School Advanced Course

a lover's moon
or
a light in the night
for
army aviators

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the sun is 18 degrees below the horizon, which is referred to as end of evening astronomical twilight (EEAT) and prior to sunrise 18 degrees to the horizon known as beginning of morning astronomical twilight (BMAT). Combat operations may be planned to take advantage of the ambient light of the sun during these periods even though ambient light is not available from the moon. It can be expected that effective ambient light will be available for about 30 minutes after and before civil twilight from mid-latitude positions. A normal function of the Air Force weather service is to provide information relating to sunset, sunrise, moonrise and moonset.

At this point this article has covered all of the information relating to hemispherical illumination needed to plan a night combat operation; however, planners must be made aware that there are other limitations which must be considered when using this information. For example, tables may reflect that the phase angle of the moon is full and that it will rise at 2100 hours. It may seem that this is an opportune time to conduct a night operation. However, if the flight route is in an easterly direction, navigation will be very difficult. This results from the extreme brightness and glare that is experienced when flying toward the moon which is on or near the horizon. A similar comparison is flying into the sun at sunset or sunrise. A delay of the operation until 2300 hours would avoid this undesirable condition of flight.

Another factor to consider when using hemispherical illumination data is the effect of meteorological conditions such as clouds, haze, smoke or fog. Each of these conditions tend to reduce the amount of available ambient light. An overcast sky condition may reduce a high ambient light level to complete darkness. Fog, smoke or haze will limit forward visibility to a point that terrain features will become unrecognizable even during high ambient light levels.

Articles beginning on pages 1, 4 and 12 discuss night vision and adaptation. Also, the March 1974 *DIGEST* covered these subjects in several articles and featured a night bibliography. [Copies are available upon request. Write to Editor, *U.S. ARMY AVIATION DIGEST*, P. O. Drawer P, Ft. Rucker, AL 36362. Additionally, readers can obtain more information relating to night flight by referring to TC 1-28, "Rotary Wing Night Flight," which is scheduled to be in print in the near future.] Information contained in these articles provides the Army aviator basic information relating to night flight and vision. Both are essential elements in training Army aviators, but additional information is essential to ensure the successful accomplishment of night combat operations. The next step in the aviator's night flight training is to learn the techniques of terrain identification at night. An aviator who is unable to identify the terrain he is overflying may become disoriented and fail to accomplish the mission.

Victory on the battlefield may be determined by the success of a mission flown by an Army aviator. His ability to perform this mission is dependent upon his training. Technological advances in weaponry require that the Army aviator develop new doctrine to counter the enemy threat. Night terrain flight is a means to defeat the enemy capability to detect and destroy friendly aircraft; however, the success of night missions is dependent upon the excellence of the Army aviator's knowledge and training.

Night Weather

Lieutenant Roger D. Thomas

Department of Undergraduate Flight Training
Fort Rucker

THE WEATHER HAD been terrible all day: heavy rain, near zero-zero conditions and numerous thunderstorms throughout the local flying area. Weather was too bad even for instrument training of our initial entry students.

One of the instructors in the flight had just called the forecaster and was told the weather would start to clear late in the afternoon. There was nothing to do now but wait for a break in the weather and get in some much needed "table talk" with my students.

Just before sunset the weather cleared nicely. The thunderstorms dissipated (or so I thought) and there was a ceiling so high our UH-1B Huey would have had to have oxygen equipment aboard before we could have even gotten near a cloud.

My students had planned a flight to Albany, GA, and everything looked good as we left for operations to check the weather and file. Little did I know then that I was about to make a series of mistakes that I would be a long time forgetting.

The weather forecast showed our destination to be VFR (visual flight rules), but I decided to file IFR (instrument flight rules) to give my students some practice talking on the radio with real controllers, rather than the simulated IFR control they were used to. The only other significant thing on the 175-1 was the thunderstorm block which was checked "few," "embedded" and "enroute." That made me decide to call the forecaster to see if he had any thunderstorms along my route of flight.

The forecaster said that the weather radar was inoperative right then, but would be back in operation in about 15 minutes. A quick look at my watch told me that we'd have to hurry to get the flight completed and get my students back before their scheduled extended downtime. So, I didn't wait to recheck the weather. This was my first mistake.

The flight began beautifully. My student made a nice ITO (instrument takeoff) and it was just getting dark as we left Hanchey Army Airfield. Departure control assigned us an altitude of 4,000 feet and it was as smooth as silk in the cool night air.

About 30 minutes into the flight, I noticed clouds forming in our route of flight. About 5 minutes later, departure control advised us that we would be encountering heavy rain showers ahead.

A little rain shouldn't be any problem and it'll be a good chance to get some night weather, I thought to myself as my student acknowledged the transmission. I had forgotten completely about the "embedded" thunderstorms listed on my 175-1. So, I decided to go into the clouds rather than get radar vectors around the relatively small area of rain showers ahead: mistake number two.

We encountered heavy rain and light to moderate turbulence when departure control advised us to

contact Navy-Albany Approach Control when passing the Tallahassee 337 Radial. I looked down to check my enroute chart to see where that would put us, thinking to myself, boy it sure got bumpy fast. When I looked back up at my instruments I was a little irate, to say the least, to see my student 500 feet off his assigned altitude and climbing at 700 feet per minute.

I had thoughts of writing out a pink slip for him until I saw the torque meter was showing 10 pounds! Things continued to get worse and as my student was having a difficult time of it, I decided to give him a break and try it myself for awhile.

Shortly after I had taken the controls, we started to encounter hail and severe turbulence. The VSI (vertical speed indicator) was going crazy; the airspeed indicator going from 60 to 110 knots (with the attitude indicator showing level flight). It was then I decided I didn't have to go to Albany that badly and started a standard rate 180-degree turn to the left, advising Cairns Approach Control of the situation and requesting a clearance to Dothan. This proved to be another mistake, for my turn took me right into the center of the thunderstorm.

About halfway through the 180-degree turn the bottom fell out. The VSI showed a high rate of descent. Instinctively I applied collective, but at 45 pounds of torque our rate of descent had not slowed and the altimeter was passing through 200 feet. The aircraft banked sharply to the left and the nose seemed to tuck down. I applied aft right cyclic, but the aircraft just wouldn't pull out.

Visions of going inverted were flashing through my mind when my student advised he thought he could see lights through the clouds. A few seconds later we broke out of the clouds. The attitude indicator showed a 75-degree bank to the left! As we hit the clear air I was able to level the aircraft and regain my altitude.

Approach control had advised it could give us vectors around the cell enroute to Albany if I wished.

"No thanks! Request clearance to Dothan with multiple practice approaches upon arrival," was my reply, and that's what he gave us.

After we all had stopped shaking and started practicing approaches, things got down to normal again and the rest of the flight was uneventful. I'll never forget, however, that helpless, sickening feeling I had when everything I tried to do with the aircraft just wouldn't work. It only lasted a few seconds, but they were enough for a lifetime.

I think I have learned a lot from my mistakes made that night. My advice to fellow aviators is to *always* obtain as thorough a weather briefing as possible and to use the recommendations from TM 1-300, "Meteorology for Army Aviation," with reference to thunderstorms.

I once heard one of the senior instructors in our flight, a Department of the Army civilian with many years of flying experience, say that when he saw "embedded" thunderstorms on a weather forecast that that's exactly where a person should be: **in bed.** I couldn't agree with him more.

I did get that night weather flying time after all! But what a way to do it!

Tactical Instrument Flying — Why?

Captain Lewis D. Ray
Project Officer
Training Developments Department
Deputy for Developments
Fort Rucker

TAC INSTRUMENTS? Sure, I know the concept! It simply means we aviators continue to do our thing even during periods of adverse weather and reduced visibility.

"But tell me something. Isn't all this talk about flying tactically in instrument conditions something of the future? In my unit we train hard and try to do as much as we can with what we've got, but we don't know the first thing about planning or flying a tactical instrument flight. Where can we find out how to do it?

"And besides, when we get it all planned, how is it all going to be controlled and coordinated? You can't tell me that there's going to be ATC (air traffic control) on the modern battlefield! Just how do we go about it and how does it work? Besides, I'm not convinced that there's a need for tactical instrument flight!"

This type of talk often can be heard around aviation units when the subject of flying tactical instruments is brought up. And, frankly, many of the questions asked have been previously unanswered. Just how do you plan for a tactical instrument flight? Who are you going to talk to? How will flight following and clearances be coordinated? And, most importantly, ***just why do we need to fly tactical instruments?***

To answer some of the many controversial questions being asked, this article is presented to provide "food for thought" on tactical instruments. It will be followed in subsequent issues by "Planning a Tactical Instrument Flight"; "'Above The Best' But Below The Threat"; and "Air Traffic Management and Tactical Instrument Flying."

Currently, the concept of tactical instrument flight is undergoing rapid growing pains similar to those experienced a few years ago when Army aviators began talking and thinking about nap-of-the-earth (NOE) and all its tactical applications and potentials. If you remember, early thoughts on NOE were developed, used, and evolved into valid, concrete concepts of terrain flying—convincing skeptics that there really is something to this business of "creeping and crawling" with the helicopter as does the Infantryman in combat. The situation is the same with tactical instruments today. There are no "pat" answers in tactical instrument flight—just some workable, early concepts that *will work* using the current equipment on Army aircraft. All we have to do is to work on it, develop it and use it. Like NOE, tactical instrument flying can be the key to success and survival on the high threat battlefield.

For some time skeptics have raised questions concerning the validity or need for a standard instrument ticket—especially for attack and observation helicopter pilots who rarely fly in a formal, controlled instrument environment such as is present in the Continental United States. However, in the current doctrinal context of the modern high threat battlefield, the standard instrument ticket takes on a new significance since it also provides the capability of conducting tactical instrument flight with a degree of tac instrument training. And, the need for a tactical instrument capability is easily documented.

Tactical instrument flight provides the commander the capability to extend aviation operations against the enemy during periods of severely reduced visibility. It is a forward area operational capability. Using tactical instrument flight, the commander can accomplish a mission under instrument meteorological conditions in a high threat environment that could not be accomplished using other flight techniques.

It is also possible for the aviator to transition from conventional instrument flight in rear areas to low altitude operations in forward areas where enemy electronic warfare (EW) capabilities and weapons threaten. A combination of terrain flight and tactical instrument flight will enable aerial scouts to provide reconnaissance and early warning; attack helicopters to provide firepower; and utility and cargo helicopter operations to continue, even under extremely low visibility conditions.

All Army aviators operating in forward areas in any helicopter should plan on the possibility of transitioning from VFR (visual flight rules) tactical operations to tactical IFR (instrument flight rules) flight (and back again, if necessary) to enhance mission accomplishment and tactical staying power.

Tactical instrument flight provides the means to ensure maximum support of ground tactical units. Survivability will require flight techniques which go beyond the use of today's conventional airways and navigational aids. Sophisticated approach procedures and equipment will not be available. Instead, flight will be performed under austere conditions requiring the highest level of *aviator proficiency rather than equipment.*

Aircraft will be operated routinely at reduced altitudes with minimum navigational aids and

This is the second of seven stories which will appear in the *DIGEST* with a subtheme "tactical instruments." The first article entitled "Tactical Instruments" may be found in the October issue, page 17. Next month watch for "Planning a Tactical Instrument Flight" and remaining stories in succeeding months

minimum air traffic control facilities and regulations. Increased dependence on preflight planning and aircrew proficiency will be essential to accomplish the mission using the tactical instrument mode of flight. Out of necessity, commanders will come to consider tactical instrument flight to be a basic aviator qualification and train their aviators to achieve an acceptable level of proficiency.

First and foremost, Army aviators must be ready and able to respond to the tactical needs of the commander. If his needs include a capability for around-the-clock flight capability, then the aviator has to be ready. This necessarily dictates the real need for tactical instrument flight.

So, the skeptic says: "I'll buy that, but we don't have the equipment on our aircraft yet to enable us to safely perform tactical instrument flight. We can't do it without equipment like a radar altimeter or an onboard self-contained navigation device."

Training is the key! Tactical instrument flight can successfully be accomplished using current onboard equipment if a diligent and thorough training effort is undertaken—not just for aircrews, but for air traffic management and pathfinder personnel as well. Through testing, training and practice, the capability can become a reality. Tactical instrument flight training not only should familiarize aviators with the principles and employment of tactical instrument flight in the high threat environment, but it also should teach them to execute an instrument flight and approach into a landing zone using minimum electronic communication and navigation devices and that such flight can be accomplished safely. Unit training should be oriented toward accomplishment of the unit's mission under adverse weather and threat conditions day or night with a minimum of assistance from electronic communication and navigation devices.

Units can incorporate tactical instrument functions into their everyday missions: Flying at lower altitudes; minimal use of available navigation and communication equipment; detailed premission planning; and postmission debriefing are training practices that can be used on a routine basis during normal operations. Training should emphasize flexibility in order for aviation elements to be able to respond quickly and reliably in a wide range of adverse weather situations.

Remember, in the next war (where we'll fight outnumbered) we won't have the time to mobilize—to get ready. We won't have the time to "break-in" air mission commanders or to train aviators in tactical instrument flight procedures. Replacement personnel will have to be combat ready—able to fill the vacancy and learn only the unit SOP. Such a potential environment dictates readiness right now. This includes tactical instrument flight.

The skeptic who questions the ability to conduct tactical instrument flight using current equipment should consider the time when the equipment he desires *is* on Army aircraft. What then? Do we wait until then to train? Or do we train now in order to be ready when it comes? The answer is obvious since both training and the capability are within our control now.

Let's take another look at the standard instrument ticket! Let's suppose for a moment that all Army aviators do not need standard instrument ratings but should possess tactical instrument capabilities. It requires *more* training and a *higher* degree of ability to fly under tactical instrument conditions than under conventional, standard rules. Additionally, the Army requires aviators to complete an annual written examination and standardization flight each year. The primary difference between the tactical and standard instrument capability is procedural—a proficiency which could be maintained through study and testing with the annual written exam and standardization flight. It seems clear then that the standard instrument capability can easily be an extra benefit derived from a tactical instrument capability. What a benefit at so little cost!

Tactical instrument flight concepts and procedures are still in the embryonic stages. You may have some good ideas. Your unit already may be using a technique or procedure to conduct flight during tactical instrument conditions. Whatever the case, we can't stop here. Development of tactical instrument flight into a routine capability to be used when needed must be every aviator's goal.

Next month: "Planning A Tactical Instrument Flight."

The author is a project officer in the Doctrine Division of the Training Developments Department. Captain Ray has completed the Armor Officer Basic and Advanced Courses and is a Senior Aviator. He has a B.A. in History and an M.Sc. in Guidance and Counseling. The author has been conducting extensive studies concerning tactical instrument flight

Communicate Through The DIGEST

NO MATTER WHAT your job is, there is something about it or something that you have experienced that is of interest to the professional people who read the *U. S. ARMY AVIATION DIGEST* each month. You *know* what is happening and where it is happening and we invite you to share your experiences with others interested in Army aviation.

The *DIGEST* continually seeks to keep those involved in Army aviation informed about the most recent advances in tactical doctrine, operations, maintenance technology and aviation safety. The magazine also serves as a sounding board for new ideas which further the cause of Army aviation and it promotes esprit de corps by noting significant accomplishments.

You, the reader, can do your share to help make this goal a reality by sharing your knowledge, experiences and ideas through the *DIGEST*.

This is how to do it. Anyone can submit an article to the *DIGEST*. When your manuscript is received several things happen. First, you get a letter of acknowledgment; then if the *DIGEST* prints the article, a letter crediting you with having had an article published is placed in your 201 file at your branch at Department of the Army. Third, your published article is entered in the monthly award competition. If you win, you receive a certificate plus a $25 U. S. Savings Bond. Also the article becomes eligible along with other monthly winners for the annual awards contest. The three best of the year are selected and the first place winner receives an engraved plaque, a certificate plus a $100 U. S. Savings Bond; second and third places receive certificates plus $75 and $25 U. S. Savings Bonds, respectively.

You don't have to be a professional writer to contribute to the *DIGEST*. Our authors come from all walks of life. Don't worry if your article is not perfect grammatically or does not conform to *DIGEST* style. The staff will edit the manuscript and correct such errors.

Material submitted to the *DIGEST* varies from pictures, letters, ideas and suggestions to full articles. Any material that falls within our mission is welcome. However, as an official Department of the Army publication, the *DIGEST* follows guidelines which limit the publication of certain types of articles. For instance, material which tends to publicize units or individuals for the mere sake of publicity is not printed. If you have any doubt about the acceptability of the item, either send it and let us be the judge or query the *DIGEST* prior to writing the story.

Whenever possible an author should contact the *DIGEST* before beginning his article to be sure he is on the right track. This can be done in person, by telephone or by

- **Get something down on you a tool to work with. T down as you do, using your too far off. At this point don mar, sentence structure and**
- **Read what you have writ you may have forgotten. As and spelling.**
- **Now look at your article not directly connected to th that does not carry the story**
- **Put the story away for a fe and reread it. After this rest you let pass.**

on paper as soon as possible; it gives
h. Tell the story to yourself and write it
your outline to keep you from wandering
don't worry about such things as gram-
and spelling.
written and add any detail or little thing
. As you rewrite, correct your grammar

icle *objectively*. If you have said anything
to the story, or if there is anything in it
story forward, cut it out.
a few days "to sleep." Then take it out
rest, you will be able to see many flaws

mail. All military personnel are authorized to deal directly with the *DIGEST*. To ensure technical accuracy, manuscripts are reviewed by experts in the particular field with which they deal. For example, a story on flight training normally would be reviewed by the U. S. Army Aviation Center at Fort Rucker and an article dealing with aircraft design or modification can be sent to the U. S. Army Aviation Systems Command at St. Louis. Many articles are reviewed by the Department of the Army to ensure compatibility with official government policy and to ensure that they do not contain classified information.

The author has the option of clearing his story through the Office of the Chief of Information, Headquarters, Department of the Army, prior to submission, or he may send the manuscript and let the *DIGEST* handle the clearance. These safeguards protect not only the author but also the *DIGEST* and the government against printing misleading, false or even libelous information. Also, reviewing agencies often improve an article by adding current information that may not be readily available to the author.

What would we like for you to write about? Anything covered in our mission is suitable. The following topics are offered as suggestions:

- Army aviation flight tactics and techniques.
- Night operations.
- Maintenance, operations, safety, etc., practices that save time, money and materiel.
- New uses for Army aviation or its equipment.
- War stories or personal flight experiences that bring out new or unique tactics, techniques or safety procedures.
- All phases of professionalism in the aviation program.
- Research and development projects.
- Humor, with a teaching point.
- Historical aspects that tend to establish an Army aviation heritage or to build esprit de corps.
- Anything expressing original constructive thought on Army aviation.

In selecting a topic it is generally best to choose one with which you are familiar. If you or someone in your unit has found a new, better or safer way of doing something or has had a personal experience of value to others in the program, write about it.

Once you have made your selection, make an outline of what you want to say. At this point, a visit or call to the *DIGEST* could make the difference between failure or success. A member of the staff will be able to tell you whether or not such a story would be of value to the *DIGEST* and how best to proceed from there. With a firm outline you will find that you won't ramble or omit important points. Keep the average reader in mind.

Don't assume that all the readers will understand terms that you use every day in your job. Identify all such terms in your article. By having an interesting and attention-getting lead paragraph you will be able to catch the reader's attention and then focus it on what is to follow.

Illustrations are important supplements to the written word and will be helpful in holding reader attention throughout the article.

The continuity of the story must be developed from the very beginning and should not be overlooked when the concluding paragraphs are written. If the story doesn't have a surprise ending or a natural conclusion you might try tying the ending back to something mentioned in the lead paragraphs.

Another important item to be aware of, especially when writing about technical subjects, is the accuracy of facts and figures. Although we will check them for accuracy, this detail is really your

responsibility. If you are unable to verify statistics, call this to our attention.

Permission must be obtained from copyright owners to reprint quotes of more than 200 words. Plagiarism—an ugly word for stealing another author's original work—could make you, the *DIGEST* and the Government subject to legal action. Be sure to credit your sources if the idea is not solely your own.

Whenever possible include appropriate, captioned photographs, artwork, charts or diagrams to illustrate material. The readability of any article is enhanced by good illustrations. If you are not sure what is needed, send what you have and let us decide what to use. Below are some general guidelines concerning supporting material:

- Use protective cardboard for illustrations during mailing and do not use staples or paper clips on pictures. Use cellophane tape or masking tape to attach captions to the back of the photo.
- We prefer black and white glossy prints or their negatives. We can use color photos but they do not reproduce as well.
- Get a professional photographer if possible to take the pictures.
- Captions should include the full name and rank of each individual, if known, and a description of what is taking place in the photo plus where and when.
- Be sure to credit proper sources for illustrations. Obtain written permission to use photos from outside sources, or advise us of ownership so that we may obtain this permission.

We prefer that manuscripts be typed on standard size bond paper—double spaced. Do not send carbon copies unless you verify that the *DIGEST* is the only recipient of the article. If you do not have access to a typewriter, we will be happy to receive your handwritten material.

Manuscripts should run from 2,000 to 3,000 words, but we realize that many subjects require a greater or shorter length. The best guidance we can offer is to make the article long enough to tell the story without omitting meaningful information or adding excess wordage that adds little to the effectiveness of the story.

It is important that you send a short biographical sketch to include your rank, Social Security number, branch, a permanent address, current assignment and other information you feel is appropriate. We are especially interested in any significant facts in your background that tend to lend credence to the subject matter about which you write. If you change assignments, address or are promoted before we have printed your article, send the new information to us.

While style and composition are definitely important, our main concern is what the author is saying rather than how he says it. We can correct grammar and smooth out an article, but it is solely the task of the author to convey the meaning and thought that he is trying to get across.

Although there is not a monetary reward for authors who do not win the monthly award, the satisfaction gained by writing for the *DIGEST* will help you in your future military career. The ability to express yourself clearly and concisely in writing, as well as in speech, is a requisite of any profession. And you will be credited in your 201 file and receive a certificate for having an article published in the *DIGEST*.

Begin writing your article today. Send your manuscript to the *U. S. ARMY AVIATION DIGEST*, P. O. Drawer P, Fort Rucker, AL 36362. For those who would like to visit or call, the *DIGEST* office is in building 518 at Fort Rucker and the telephone number is—commercial: (205) 255-3619; AUTOVON: 558-3619.

Watch For . . .

The January issue of the *DIGEST*. The "After Sunset" theme will be continued with the feature story "Soviet Night Operations" and other articles encompassing night tactical flight concepts and experience.

Excellent articles concerning night vision, particularly oriented to aviators, have been published:

"Oh Say Can You See," LTC Nicholas E. Barreca, June 1971
"Visual Illusions," LTC Nicholas E. Barreca, June 1972
"Night Train," MAJ Rush R. Wicker, March 1974

The Night Bibliography which appeared in the March 1974 issue is being updated and will be sent to readers on request. Individual copies of the referenced stories will be forwarded to those making written requests (see last paragraph above).

Continued from page 11

Thompson should be required reading for any pilot, military or civilian; and I do find that your magazine is well read whenever I can scrounge a copy for the club office.

I don't know that we have either the local writing expertise or any timely subject for an article; however, if we should ever come up with something, it would be interesting to know if the *DIGEST* might be willing to consider it.

Major W. L. Benson Jr.
Redstone Arsenal, AL 35809

• The *DIGEST* is indeed anxious to receive articles from and about Army flying clubs.

The last Army flying club coverage appeared in the March 1974 issue.

Sir:

Reference "That Certain Feeling" (June 1975 *DIGEST*), I prefer to refer to these as famous last words:

"Now I don't ever want you to try this solo, but this is the way we did it in Vietnam."

"Don't worry, if the weather starts closing in we'll just set it down in a field."

"No problem general, my people can hack it."

"We don't have a safety SOP right now—but here's a draft we borrowed from the fixed wing detachment."

"Sure, I believe in safety—as long as it doesn't interfere with the mission."

"Let's see now—30-foot pounds. That feels about right."

"You have 30 thousandths play on this part and that only looks like 20 thousandths."

"We don't have to write it up—it didn't feel like we landed *that* hard!'

"You better expedite your preflight—the general is waiting."

"Just transfer it to the dash 14."

"We don't need pathfinders—we've landed near there before."

"I don't read the *DIGEST*—it doesn't have anything that applies to me."

CPT Benjamin F. Vandervoort
HQ, 101st Airborne Division (Air Assault)
Fort Campbell, KY 42223

Sir:

Reference the article, "New Warning Light, A Drugstore Hazard," by CPT Bruce Klosterhoff, M.D., which appeared in the August 1975 issue of the *AVIATION DIGEST*.

In paragraph 2, phenylpropanolamine is listed as one of the antihistamines contained in many well-known medications sold over the counter.

Phenylpropanolamine hydrochloride is the hydrochloride of racemic-1-phenyl-2-aminopropanol, with actions similar to those of ephedrine. Its action is that of a bronchodilator and local vasoconstrictor—which is the complete opposite of an antihistamine.

CPT Edward J. Brzezinski
Executive Officer
444th Medical Company (Clearing)
Chicopee, MA 01022

• CPT Brzezinski is right when he says PPAHCL is not an antihistamine. It is related to the drug ephedrine in structure and action, being a vasoconstrictor and bronchodilator. Its use (PPA) is as an oral decongestant (directed nasally). However, it is inaccurate to call ephedrine or PPA as a local vasoconstrictor unless it is used locally. PPA used orally has effects in other vascular beds besides the nasal one. It also is inaccurate to say that the action of PPA is the complete opposite of an antihistamine. An antihistamine is not a vasodilator or bronchoconstrictor. An antihistamine preparation antagonizes the effects of histamine. Thus, they antagonize histamines effect to vasodilate and bronchoconstrict. Thus, the action of an antihistamine is tending to act in one same direction as PPA, but not in an active sense.

STANDARDIZATION CORNER

SOME UH-1 Huey and AH-1 Cobra operators have asked for information about crosswind component effects on nonstandard maneuvers, i.e., autorotations, hydraulics off, antitorque failure and running landings.

According to the U. S. Army Aviation Systems Command (USAAVSCOM), flight test data has not been established for this type training. However, the following recommended limitations have been established at Fort Rucker for training purposes only and are published for your consideration.

Wind Angle (from runway heading)	Wind Velocity
0 to 15 degrees	25 knots
15 to 45 degrees	20 knots
45 to 90 degrees	10 knots

The recommended maximum wind gust spread is 15 knots.

We must emphasize here that these are guidelines only and in no way imply that training cannot be conducted under other conditions. However, if training is conducted where wind conditions exceed these recommended limitations, you should consider the following:

• Headwinds greater than 20 knots usually cause steeper than normal descent angles. This may affect the pilot's depth perception during autorotative maneuvers.

• A sideslip angle of 10 degrees will result in a rotor hub-to-mast clearance of only 2 to 3 degrees. Under this condition, mast bumping can easily occur upon touchdown.

• Directional control may be substantially reduced, particularly with low rotor revolutions per minute. Check out paragraph 3-40 of your UH-1 dash 10 for more on this. (This chart applies to both UH-1 and AH-1).

At Last— REALISTIC Aerial Gunnery Training

Captain Donald B. Skipper

Student Detachment. U. S. Army Armor School
Fort Knox, KY

A NEW TRAINING circular is being published on aerial gunnery training. Written by the U. S. Army Armor School, Fort Knox, KY, TC 17-17, "Gunnery Training for Attack Helicopters", is a guide to the conduct of unit level aerial gunnery training. It is designed to prepare helicopter crews to meet the challenge of placing effective fire on the enemy and surviving outnumbered on the modern battlefield without being destroyed by enemy fire.

What will the next war be like? How will our helicopters have to fight in a mid intensity high threat environment? Though no one can answer these questions with certainty, TC 17-17 analyzes certain facts to prepare attack helicopter pilots to fight in such an environment. The 1973 Mideast War confirmed what the Armor School perceived a modern, mid intensity battlefield to be. The airspace above such a battlefield will be dominated by threat long range antiaircraft cannon and missile systems. These weapons are so accurate and lethal that: *What can be seen can be hit—what can be hit can be killed.*

Defeating these weapons will be the key to winning the battle. Early battles of the next war probably will be short and violent. Each side will be fighting to win substantial gains quickly. These gains will give leverage at the bargaining table if negotiations are undertaken to end the conflict and avoid nuclear war. *Winning the first battle of the next war is essential.*

In order to win, the U. S. Army must have coordinated teams and sections, and this requires the efforts of integrated crews. To meet these requirements, aerial gunnery training must begin with the development of individual skills and progressively build through the crew and team/section levels with standards of performance set at each level.

The new aerial gunnery training standards in TC 17-17 are based on maximizing the advantages of the aerial weapons platform (speed, mobility and firepower) and minimizing aircraft disadvantages (thin skin and limited load carrying capability). These standards represent the minimum level of proficiency required to make the attack helicopter an effective fighting weapon.

The individual standards, as a basis for more advanced aerial gunnery training, must be successfully met before training can be conducted on a higher level. Well-trained individual crewmembers will permit efficient crew coordination and allow for flexibility in assigning crews in combat.

The crew standards outlined in the training circular must be met to make the aerial weapons platform an effective fighter, capable of effectively participating as an element of a team or section. The teamwork required to meet the crew standards will mold individual proficiency into efficient crew performance. At the team/section level, standards are based on the ability to coordinate the fires of air and ground maneuver elements; to integrate supporting fire; and to mass these fires on the enemy at the decisive place and time. To achieve these standards, the new TC 17-17 stresses the integration of gunnery and tactics necessary for effective combat operations.

TC 17-17 describes the aerial gunnery training program in four phases:

- The commander's training evaluation and planning
- Pregunnery training
- The Aerial Gunnery Skills Test (AGST)
- Range training

These phases are separate but interrelated. Phase 1 (commander's evaluation and planning) must precede

the other phases but will continue throughout the program. Phases may be repeated on different levels of training throughout the training year in a sustaining aerial gunnery training program, or they may be compressed into an intensified aerial gunnery training program when necessary.

In making his evaluation, the unit commander must determine his unit's current level of proficiency in aerial gunnery; what training will be necessary to meet required training standards; how much time is available to achieve those standards; and what resources are required and available to conduct the aerial gunnery training.

TC 17-17 points out the three keys to successful evaluation and planning for an aerial gunnery training program:

- Be thorough—don't leave anything to chance
- Start early to produce the desired results
- Be flexible and continuously adjust the program to meet the needs of the unit

Once the commander has made his initial evaluation, he can start the unit at the appropriate level of training, thereby maximizing efficiency and avoiding needless repetition.

Phase 2 (pregunnery training) prepares the unit to perform all tasks required in aerial gunnery range training. Some of the areas that should be a part of pregunnery training and are discussed in TC 17-17 are flight proficiency, map reading, navigation and terrain analysis, armament, ammunition, crew duties, target acquisition and identification, mission planning, range operation and safety.

Phase 3 (the Aerial Gunnery Skills Test) determines if pilots and ground crews are ready to advance to the range training phase. The AGST is also a valuable diagnostic tool for the commander in his evaluation and planning. TC 17-17 presents a sample AGST and scorecard and a suggested layout for the conduct of the test.

The range training—phase 4—is the conduct of all the aerial gunnery training tables. These tables are divided into three levels of training:

- Individual tables I - VI
- Crew tables VII - IX
- Team/section tables X - XII

All the aerial gunnery tables contained in TC 17-17 are designed to build on the basic skills acquired during the pregunnery training program and provide the unit commander with maximum flexibility in maintaining Army-wide standards. Although the tables add emphasis to night crew and team/section training and introduce the employment of 2.75 inch rocket at extended ranges in the overwatch role, they are not the end of imaginative training, just the beginning.

TC 17-17 provides firm guidance concerning minimum training standards and some innovative ideas to make training more interesting, challenging and realistic; *it is not intended to limit training to those minimum standards*. For example, if the unit is ready to use organic or attached infantry for target hand-offs, or to call for and adjust indirect supporting fires as a part of the team section tables, it should do it.

The individual tables are designed to cross-train and qualify crewmembers to perform duties associated with each position in the type or configuration of attack helicopter that they will be operating in the unit. The crew tables produce the coordination required for the team/section to destroy the enemy. The scoring of the aerial gunnery tables is based on the same basic factors that produce success in combat. These include target effect, aircraft exposure time, technique of target attack and the efficient use of ammunition.

The ability to win and the ability to survive are interdependent and both are products of realistic training. Only realistic training can give attack helicopter crews the skills and confidence necessary to provide the edge that will allow us to fight, outnumbered, and win the first battle of the next war. The new TC 17-17, "Gunnery Training for Attack Helicopters," is directed to that goal.

USAAAVS
Earl W. Mundy Jr.
Aerospace Engineer
U.S. Army Aviation Systems Command

Something you're sure to get a bang out of

COMPRESSOR STALLS

PERHAPS ONE OF the most common and least understood phenomenons incurred by operators of Army gas-turbine-engine-powered helicopters is the compressor stall or "surge." Never a pleasant experience, and very possibly a dangerous one, surges can cause damage to airframe components. The surge is here to stay as long as FOD (foreign object damage), sand and dust, mechanical wear and human error exist. A better understanding of what a "surge" really is and why it happens is bound to be of interest. And just possibly a more thorough understanding of "surges" may be of help in avoiding them, or at least in avoiding undue panic if one does occur.

Figure 1 shows a simplified compressor performance chart. The surge line here is defined as the pressure ratio/airflow limit of stable operation. The operating line shows the pressure ratio/airflow relationship for the compressor as it is actually operated and illustrates a surge "margin." This "margin" is the distance between the operating line and the surge line.

As long as this "margin" is maintained, compressor performance remains satisfactory, with smooth accelerations and decelerations at all altitudes and temperatures. If, however, for some reason the operating line shifts to intersect the surge line, compressor stability is compromised. With the compressor operating to the left of the surge line a blade or stator vane somewhere in the compressor will stall. The design of most axial compressors would place the operating line to the left of the surge line in lower speed acceleration. For this reason a compressor air bleed device is used to reduce the compressor pressure ratio during these accelerations and thus to place the operating line properly to the right of the surge line.

When a blade or vane stall occurs it is accompanied by a sharp local drop in pressure. More blades or vanes stall—and then total flow reversal

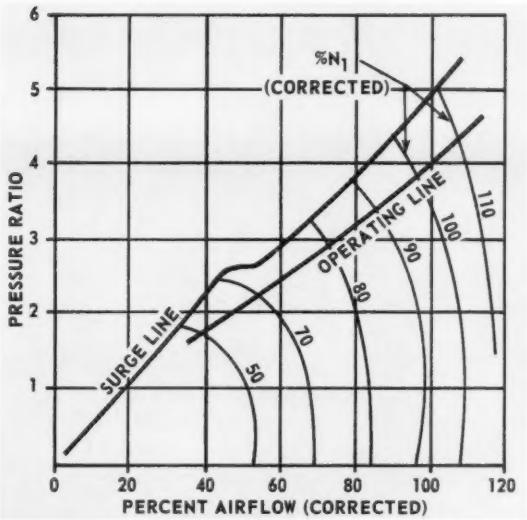


FIGURE 1.–Typical Compressor Performance Chart

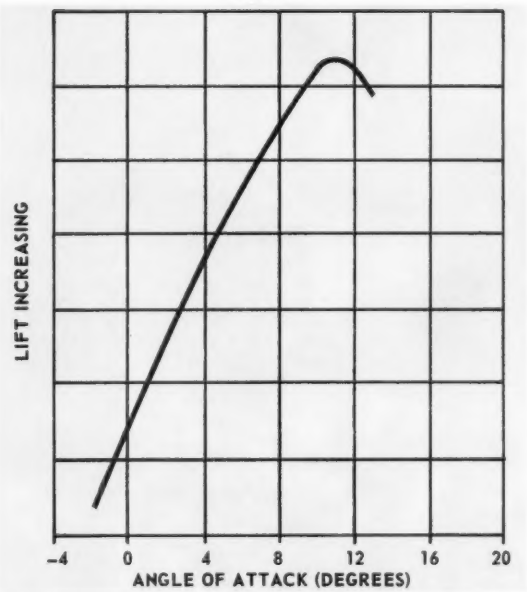


FIGURE 2.–Simplified Lift Curve for An Isolated Airfoil

occurs. This may cause a single "bang" or a series of "pops" as the stalls cycle through the compressor. The latter situation is more common where the pulsating airflow causes rapid variations in N_1 speed and torque. The key event in the surge then is the shifting of the operating line and the initial stalling of a single blade or vane.

In examining the stalling of a single compressor blade, it must be remembered that the function of a compressor is to deliver the required amount of air to the combustor section at the proper elevated pressure. The compressor is able to raise by some incremental amount the pressure of the air as it passes through each stage of the compressor. It is able to do this using the capability of blades and vanes (airfoils) to produce lift. Just as the lift of a wing or rotor blade supports the weight of an aircraft against gravity, the sum of all the incremental lifts of all the blades and vanes in an engine supports the high-pressure reservoir of air in the combustor.

Considering each blade or vane as an isolated airfoil (figure 2), it can readily be seen that as the angle of attack of the airfoil increases, the lift increases as well, to a point. Then suddenly, lift decreases and finally ceases altogether. This occurrence is known as stall. While the actual angle of the compressor blade or vane (airfoil) is fixed, due to changes in N_1 speed, the velocity of airflow and to

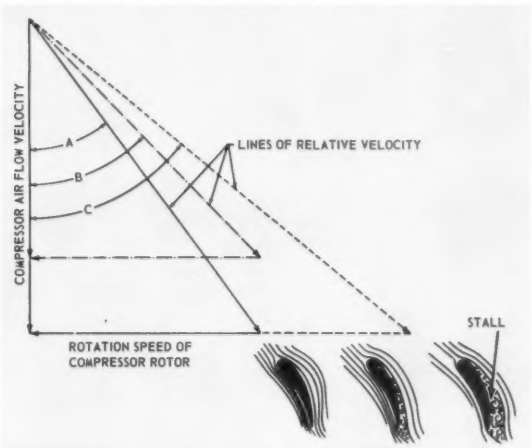


FIGURE 3.–Airfoil Angles of Attack vs. Lift

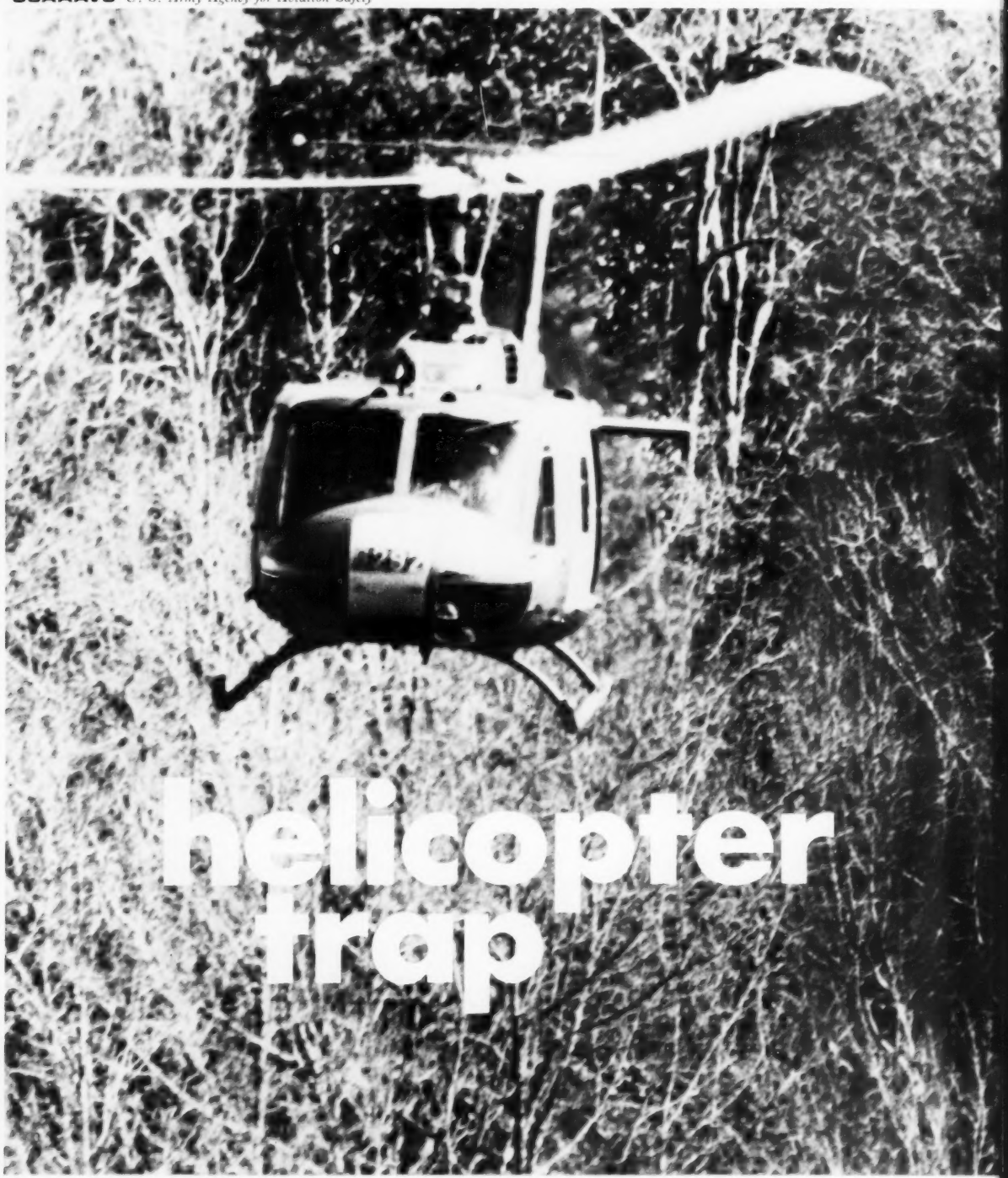
a lesser degree to other factors, their angle relative to the air flowing through the compressor does change and stall can occur (figure 3).

So, if an engine is designed with surge "margin," what causes the alteration of the operating line, the loss of this margin and, hence, surges? A number of things can be responsible:

- Foreign object damage changes the aerodynamic characteristics of a compressor blade or vane, making it stall at a lesser angle of attack than an undamaged blade.
- Erosion changes the shape of the blades, stators

Continued on page 34

Captain Don A. Mynard
Directorate for Aircraft Accident Analysis and Investigation
U. S. Army Agency for Aviation Safety



helicopter trap

TERRAIN FLIGHT training is rapidly spreading throughout the Army, and as it does, we can logically expect the incidence of tree strikes to increase. However, this doesn't necessarily have to be the case. As opposed to wire strikes, which usually occur because pilots do not see the wires in time, if at all, to prevent contact, most tree strikes generally occur with the trees in full view. In fact, a study of accident reports indicates that pilots often strike trees when avoiding them would have been easier. An extreme example of this involves a fixed wing aircraft and dates back to the days of the L-19 Bird Dog (later designated O-1).

In this instance, two experienced pilots were making a cross-country flight in separate aircraft when one aircraft developed engine trouble and was landed in a large open field. The pilot of the other aircraft followed the first. After securing the defective aircraft until repairs could be made, both pilots climbed into the second L-19 and prepared for takeoff. The field was relatively smooth, long and free of obstructions—except for a single tree. Because of the tree's prominence, the pilot in the rear seat made no comment concerning it to the pilot at the controls. During takeoff, the aircraft struck the tree, killing the pilot in the front seat, seriously injuring the second one and destroying the aircraft. Why? We can only speculate.

A less spectacular mishap occurred more recently when a pilot clipped the same yucca tree two days in a row. Again we can ask why. And again we can only speculate.

During the period FY 1970 to FY 1975, Army pilots were involved in 717 tree strikes. These resulted in damage costs that exceeded $14½ million. Granted, many of these mishaps occurred during resupply missions, extractions of troops and evacuation of wounded in Vietnam under far from ideal conditions. But even when we discount these, the incidence of tree strikes remains unacceptably high.

Part of the problem stems from inexperience or a breakdown in air discipline in performing terrain flying (NOE—variable airspeed and altitude; contour—constant airspeed, variable altitude; low level—constant airspeed and altitude). But there is more to it than that. Even highly experienced aviators can find themselves involved in tree strikes. During the making of a training film, two IPs, both NOE instructors, were to hover an AH-1 Cobra along a prescribed path in a confined area. While the film crews set up the camera, the Cobra crew thoroughly reconnoitered the area and made a trail run, allowing an extra margin for safety. When they were satisfied all was in readiness, they proceeded with the live run. As the camera "rolled," the crew guided the Cobra along the predetermined flight path. Suddenly, leaves and twigs began to fly in all directions as long, thin, flexible branches stretched into the path of the rotor blades. While damage was minimal, this mishap was highly significant as to why tree strikes occur so frequently during operations in confined areas.

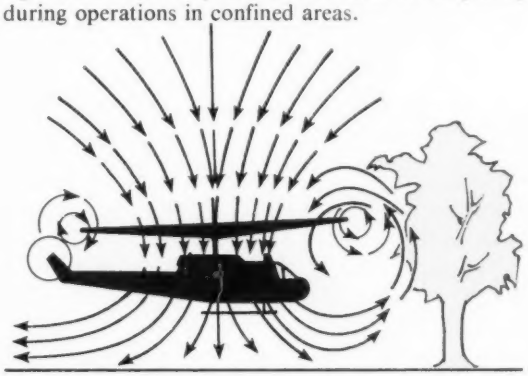


FIGURE 1

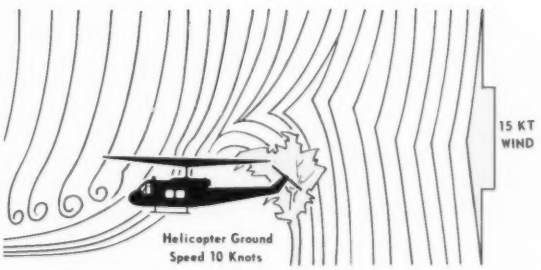


FIGURE 2

When a helicopter hovers, the rotor system must move a tremendous volume of air every second. This air must be drawn from the surrounding air mass, and results in a giant pumping process. When an obstacle is placed near the air flowing through the rotor system (figure 1), it causes the airflow to swirl vertically upwards and then back down through the rotor. If the object happens to be a tree with elastic limbs, then branches and leaves may be sucked into the rotor. This situation is more likely to occur during hover in a confined area or when landing downwind without adequate rotor clearance.

During an NOE approach downwind into a confined area, the airflow through the rotor at translational lift will likewise tend to draw tree limbs into the rotor, particularly from the rear (figures 2 and 3) when passing through a narrow opening in the trees.

Because of the numerous variables involved, such as

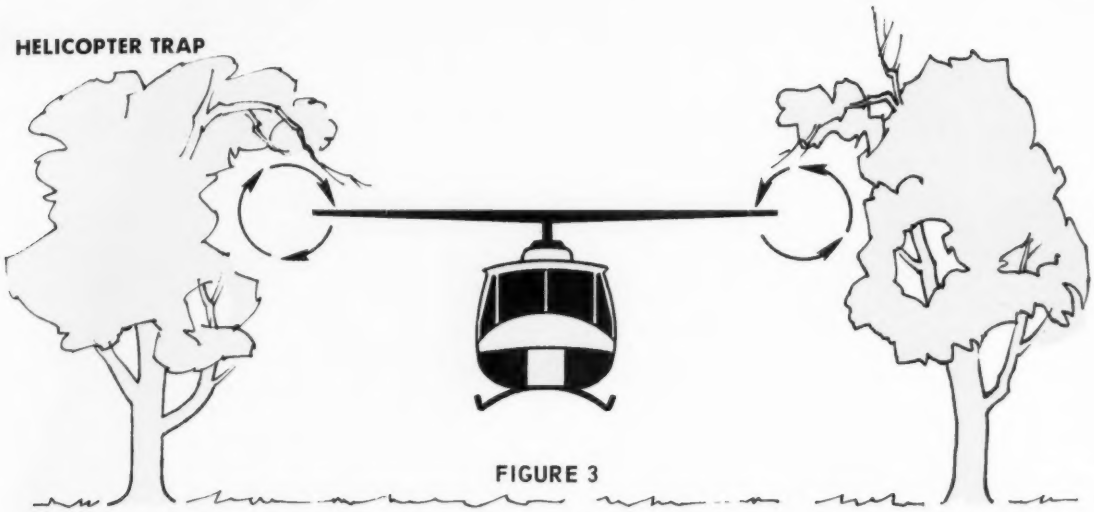


FIGURE 3

the elasticity of tree limbs and unpredictable winds, it would be extremely difficult, if not impossible, to establish a realistic minimum tree clearance distance that would guarantee safety in all instances. However, we can greatly decrease the chances of tree strikes by adhering to the following recommendations:

- Contour and NOE flying should only be performed in authorized areas.
- Know your aircraft and develop proficiency in judging distances from all portions of it.
- When operating in confined areas, coordinate with all crewmembers aboard so as to remain constantly alert to the hazards surrounding your aircraft.
- Make certain each pilot is aware of the aerodynamics of a hovering helicopter and the various conditions that could cause limbs and branches to be drawn into the rotor. Keep in mind that dead branches as well as any broken ones suspended in trees can readily become flying missiles.
- When operating NOE, the aircraft should be flown no lower than necessary to remain masked. Seldom will there be a need to fly the aircraft with the fuselage below the tree tops and the rotor barely protruding above the trees. In some terrain, such as mountainous regions with deep canyons, ravines or wadis, the aircraft can be maintained more than 1,000 feet agl and still be masked.

While these recommendations are few and simple, they are effective and will go a long way toward preventing tree strikes—if we take them seriously. Let's vow to do so, and avoid this ever-present helicopter trap.

COMPRESSOR STALLS

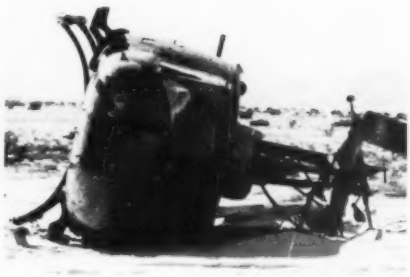
continued from page 31

and other compressor components. Aerodynamic characteristics of blades change as do airflow characteristics. An eroded compressor can perform near normal but surge unexpectedly when a blade stalls at an angle of attack somewhat less than would an uneroded blade.

- Compressor airbleed. Incorrect adjustment or malfunction can cause too high a compressor pressure ratio during acceleration. With the operating line shifted to the left of the surge line, stall is inevitable.
- Variable inlet guide vanes (VIGVs). Misrigging of the VIGVs or malfunction of the VIGV actuator or control can result in airflow changes relative to the compressor blades that will induce stall and compressor surge.
- Malfunction or failure of the P1 sensing system can result in an enriched acceleration schedule, which increases combustor back pressure, reducing compressor airflow and in effect increasing blade and vane angles of attack. Stall and compressor surge may occur.
- Dirty compressors cause reduced airflow at any given N_1 speed. This in itself is not severe enough to cause stall and surge, but when other factors are involved a stall and surge can result.
- Blockage of the engine inlet. Grass or foreign matter gathered on the cowling screens or FOD screen can contribute to a stall by alteration of airflow to the engine.

How can you reduce instances of stalls?

- Careful maintenance is a prime factor.
- Keeping screens and separators clean.
- Inspection of compressors for erosion more frequently in sandy and dusty areas.
- Ensuring correct operation of compressor airbleed devices and VIGVs, if applicable.



WINTER'S LOSERS

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THIS WINTER will probably be pretty much the same as last winter with the only differences being in the arrival time of the rotten weather and the severity of it. The same people who waited until the last minute to check the antifreeze in their automobiles will do so again this year. Then the first time the man on the tube tells us to expect a hard freeze, all of these non-boy-scout types will converge on their local service stations. They'll run the attendant ragged till way past closing time, complain about the high price of his antifreeze and then wonder why he is not his usual friendly self.

Doctors will be prescribing the same medicine for the same sore throats and runny noses. Policemen will be trying to keep the traffic moving at the same congested areas and they will be writing up the same type of fender bender accident reports.

Winter brings the same hazards with it every year. This is especially true in Army aviation and being aware of hazards is the first step of your avoidance procedures.

Icing Conditions. Icing on a cake is what makes it appealing to the eye and tastebuds, but icing on an aircraft is one of the most serious winter hazards and there is nothing appealing about it. Ice accumulation on an aircraft can be slow or dangerously rapid. Weather conditions normally associated with icing are:

- Icing occurs when the temperature is at or below

freezing and visible moisture, such as a cloud, drizzle, rain or wet snow, is present.

- Icing occurs in stratiform clouds when air is stable and water droplets are present. Water droplets may become supercooled at or below freezing and still be in a liquid state. Supercooled droplets freeze on contact with aircraft and form layers of ice. Stratiform clouds also may contain ice crystals which are not hazardous to flight because they do not adhere to aircraft.
- Icing in cumuliform clouds, with high moisture content, can occur rapidly. Unstable air with vertical currents may carry very large supercooled droplets which spread before freezing and cause rapid accumulation of ice.
- Icing in mountainous terrain occurs mainly when moist air is lifted over high peaks. Ice-producing areas are mostly on the windward side of peaks to about 4,000 feet above the peak and possibly higher when the air is unstable.
- Icing in frontal inversions also can be very rapid. Air temperatures are normally colder at higher altitudes but when air from a warm front rises above colder air, freezing rain may occur. Rain falling from the upper (warmer) layer into a colder layer is cooled to below freezing but remains a liquid. The liquid freezes upon contact with the aircraft and accumulation can be very rapid.

Winter operations require special precautions from the planning phase to touchdown at destination. The following weather rules should be observed at all times.

Planning. Planning a flight in winter weather should always be done with the thought in mind that you would hate having to walk back. Obtain current detailed weather briefing and be certain you understand all weather conditions that exist or could occur en route and at destination and plan for an alternate airfield. It is essential that cold weather survival gear be carried at all times.

Pretakeoff. Check surrounding area before making runup so as not to blow snow and slush over other aircraft, runways or taxiways. Remember pitot heat, and use it. On reciprocating engines, apply carburetor heat on those so equipped in accordance with procedures prescribed by the dash 10 before takeoff —it is just as important before takeoff as during landing—when conditions warrant its use. Clear all frost from your aircraft before taking off. Frost increases drag and is hazardous at low airspeeds during takeoff. Frost also provides a surface that accelerates accumulation of ice.

Taxiing. Check condition of ramps and taxiways for ice, water, etc. Nose wheels and tail wheels are not effective on wet or icy ramps—EXCEPT AT SLOW SPEEDS. Use wing walkers when needed and allow yourself lots of space. Apply brakes smoothly, and avoid taxiing through deep water.

During Flight. Avoid flight into icing conditions. Choose altitude below freezing level if possible. Remain VFR. Staying clear of clouds will keep you away from most icing situations.

For flights in vicinity of a warm front, determine if temperatures in cold air mass are in ice-producing range (0 to -10 degrees or -20 degrees C.). Determine altitude of inversion layer. Knowledge of these facts will govern necessary action in the event you encounter precipitation.

Rotor blade icing begins near the root and ice buildup causes loss of airspeed. This requires an increase in power which leads to increases of exhaust gas temperature (egt) and rpm and causes vibration.

Ice on the windscreen of a helicopter will be the pilot's first sure sign he has entered icing conditions. Even in the worst icing conditions, side windows in a helicopter usually provide visibility.

Windscreen heaters can be effective in preventing ice from forming but are often ineffective for removing ice that has already formed. This also applies to pitot heat. Use heaters when icing conditions are anticipated.

Once icing begins, the pilot should take action to avoid further icing. Rotor blade icing causes loss of lift and increased drag. The pilot must increase torque to maintain airspeed. If torque must be increased as much as 5 psi (pounds per square inch), flight must not be continued into icing. Further icing would cause the aircraft to lose autorotational capability in a matter of minutes.

Asymmetrical shedding occurs when one rotor blade sheds ice, leaving the rotor out of balance. This can lead to severe vibrations. Shaking the stick is not a cure because this could place undue stress on the aircraft and may actually lead to even greater imbalance. Ice shedding can also cause FOD (foreign object damage) from ice ingested into the engine.

When icing is encountered, descend to altitude clear of clouds. If icing is moderate to heavy, land. Remember that autorotational capability may be lost in a matter of minutes if flight is continued into clouds.

In freezing rain, it is vital to know the altitude of inversion layer and freezing level. If freezing level is at surface, landing is not recommended. Depending on circumstances, the best solution may be to climb through the inversion layer to the warmer air mass, where ice will melt off.

Be extra alert during morning flying periods for sudden weather changes. Morning flying periods are characterized by the poorest and most changeable weather of the day. The sun's heat does not have

an appreciable effect much before noon. Consequently, nighttime fogs and low stratus clouds are slow to lift. Oftentimes, a temporary shift in the winds will blow a low stratus deck or fog bank away, only to have it come back in when least expected.

Be critical of visibilities reported as reduced by rain, drizzle or snow. Whenever a visibility of less than 6 miles is reported, the obstruction to visibility is included in the observation. (Thus the visibility will be reported "2 miles in rain, 1 mile in snow, 3 miles in light drizzle," etc.). Oftentimes, the significance of this information is overlooked. Rain and snow have an invalidating effect on vision from the cockpit. For instance, visibility as seen by a weather observer in rain is not realistic from the viewpoint of the pilot who encounters the rain at tremendous speeds—sometimes equivalent to directing a firehose at the window of the weather station. A weather observation wherein the reported visibility is obscured by precipitation should be viewed with some skepticism.

Exercise extreme care whenever the words "partial obscuration" or "obscuration" are contained in a weather report. The weather observer defines the ceiling and visibility by taking measurements in the vertical and horizontal. However, the pilot on his approach is interested in a factor known as slant range visibility, a factor the weather observer is unable to determine. Therefore, whenever an obscuration is reported, the pilot should be prepared for the possibility that the conditions he encounters will be poorer than those reported by the observer on the ground.

Where snow is forecast or listed as a possibility at destination, select an alternate where snow is definitely not expected and, if snow is encountered, proceed to it without delay. When snow reduces visibility to below minimums, it also reduces the radar capabilities of ground controlled approach (especially wet snow) by blurring the scopes, and it lowers the ceiling by obscurations. Icing may be encountered. Snow intensity is difficult to forecast and heavy snow often persists for a long period of time.

When in fixed wing aircraft, check runway conditions closely and cancel flight when the destination has ice-coated runways and temperatures are near freezing and/or rain is falling. Also cancel flight if fresh snow is on the runway or forecast to be on the runway.

Ice and snow on runways are dangerous for landing and takeoffs. Snow is particularly slippery when temperatures are near freezing. Wet snow on runways offers little friction. Ice is always slick, and when it is wet with rain, it offers practically no friction.

Where weather at destination is reported below minimums in winter, proceed to alternate without delay. In summer, daytime weather deterioration such as stratus and rainshowers may quickly give way to improvement. In winter, the sun's heating is far less than in summer and often weather deterioration and then persistence of poor conditions occur in the daytime.

In regions of suspected icing, when climbing, letting down or landing, keep a safe margin of airspeed and a minimum of extra exposed surfaces, such as wheels and flaps. Ice accumulation reduces dynamic lift and thus increases stalling speed. Extra exposed surfaces add to the amount of ice accumulation.

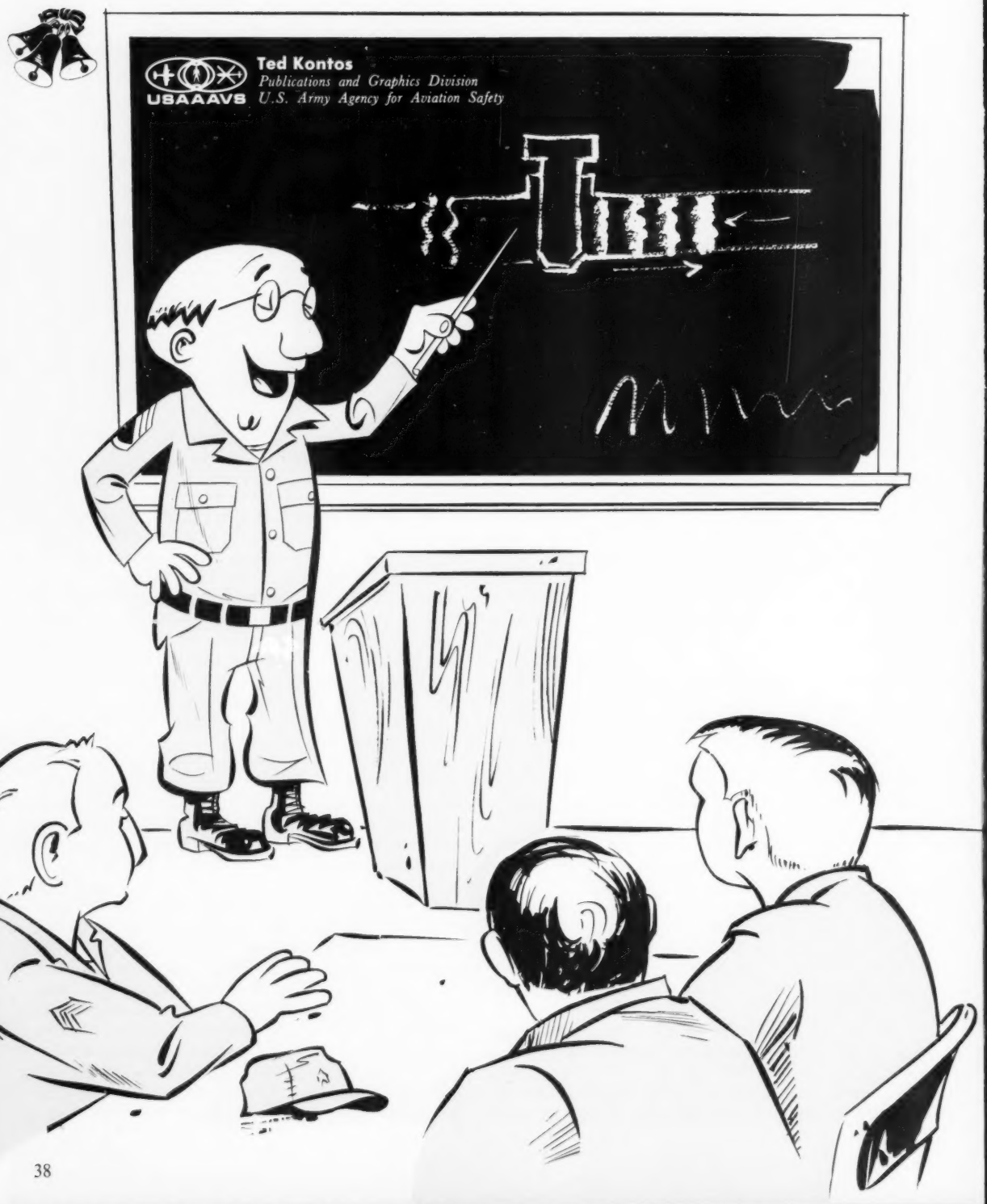
Landing. All anti-icing equipment should be on and everything warmed up before starting descent through clouds. On reciprocating engines, exposure to carburetor ice rises sharply when throttle openings are reduced. Lower powered descent in clouds and rain should always be made with carburetor heat on.

If you have flown through icing conditions, remember the effect on airfoils and carry an airspeed margin for unpredicted stall speeds. Also, landing on wet or icy runways requires longer runs. Exercise great care when landing in high winds. Crosswinds are especially hazardous in winter because they may be coupled with icy runways and blowing snow.

After a helicopter lands with ice on the rotor blades, ground crewmen should keep clear until rotor slows. Aircrew should remain in the aircraft until the rotor stops. Ice thrown from turning rotors can be extremely hazardous.

A youngster who falls through thin ice while skating on a pond is not likely to make the same mistake twice. If he survives the first time, he will be more cautious about where he skates because experience gained the hard way is not easily forgotten.

Unfortunately, when an aviator encounters a winter hazard, the lesson he learns is usually more than a chilling experience and sometimes he doesn't get a chance to make the same mistake again. This is why you must learn from the experiences of others and know the hazards you will face each winter and how to avoid becoming a winter loser.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Ever since we were introduced to aircraft maintenance, we have been told, urged, cajoled, warned and maybe even threatened to always perform all maintenance and inspections by the book. Certainly, we know if we perform a job properly, it should be right. But there is more to it than that. A look at just a single problem area associated with aircraft hydraulic systems can give us a new outlook concerning this matter.

CHITTER CHATTER

LOSS OF HYDRAULIC fluid and subsequent loss of pressure in flight is occurring aboard Army aircraft on the average of three times every month. In most instances the results are successfully performed precautionary landings. And the culprit most often responsible is chafed lines. In fact, chafed lines are found to be the cause in nearly half of all occurrences. During one month, loss of hydraulic fluid occurred in flight aboard five UH-1s. In four of these instances chafed lines were the cause. Other causes, in descending order of frequency, are improperly torqued fittings and lines, improperly installed seals and damaged tubing.

Most of us usually think of hydraulics as a combination of systems that operate flight controls, brakes, landing gear and other aircraft components. We picture these systems as a conglomeration of pumps, accumulators, tubing, valves and actuators all of which, at times, fail, leak or otherwise give some type of trouble. In reality, hydraulics is a highly specialized branch of science that deals with liquids in motion.

When a liquid flows through a closed system, it is subject to pressure pulses. A piston type pump, for example, actually moves the fluid by a series of pulsations. Even centrifugal pumps create a similar effect, although to a lesser degree. Pumps literally chop the liquid into small quantities as they force it through the system, and although the liquid appears to move in a steady stream, it is actually flowing in a rippling motion. If the designer fails to take this into consideration, the "ripple" can shake the system until it fails from fatigue. Unfortunately, this ripple effect is not the only problem plaguing the designer.

Another problem is hydraulic shock that occurs every time a valve opens or closes, or when an actuator causes the liquid to stop or change direction. When a valve closes to stop the flow of hydraulic fluid moving through a line, flow is halted almost instantaneously. However, the fluid upstream is still in motion and impacts upon that which is downstream. The result is a large and rapid pressure increase at the valve face. While this rise in pressure is momentary, it causes a pressure pulse or wave to bounce back upstream (figure 1). This wave, in turn, is modified by the plumbing in the system, such as fittings and changes in tubing material and size. Nevertheless, waves or pulses will be reflected within the system. Sometimes they will reinforce each other, and at other times, they will tend to dampen or cancel each other. Designers often detune the more extreme surges from a system by installing a section of flexible hose in place of one made of rigid tubing. This allows the hose to flex and dampen the pulsations.

CHITTER CHATTER

A somewhat similar effect occurs when a valve is suddenly opened. All the fluid will not begin to move simultaneously. Instead, fluid from the pump will overtake the fluid downstream from the valve, and pressure will build up and be transmitted as a shock wave through the system. And the faster a valve opens or closes, the higher the pressure buildup and the more severe the shock wave. Consequently, one method used by engineers to help correct a shock type problem is to incorporate slower operating valves. Pistons in hydraulic actuators also cause shock waves during operation. When a piston reaches the end of its travel or changes direction, the effect is much like that of a valve closing.

As if the problems inherent to hydraulic systems are not enough, we often let others creep in. If a hydraulic system is not self-bleeding, air introduced into it becomes trapped and can cause pressure surges similar to those described. When air passes through a hydraulic pump, it is emitted in the form of tiny bubbles that travel throughout the system. When these bubbles reach a restricted opening, such as a valve, they cause high pressure surges. These surges are severe enough that if they are not dampened, they can cause failure of such components as hoses, fittings and even pump bearings. Keep in mind that high pressure surges anywhere within a hydraulic system can travel throughout the system.

Despite their best efforts, engineers cannot design a hydraulic system that will completely eliminate surge problems. Consequently, they resort to surge suppressing devices. Fortunately, the accumulator commonly used to store energy is one of the best available. Located between the pump and valves in the system, it absorbs shocks effectively. While accumulators vary in size and type, all function in a similar manner. A typical accumulator may consist of a cylinder with a free-floating piston inside it. One end of the cylinder may be charged with air or an inert gas to a specified pressure, forcing the piston towards the opposite end which is open to the hydraulic system. During operation, hydraulic fluid under system pressure forces the free-floating piston along the cylinder, compressing the air or gas behind it. When components are actuated, system surges are absorbed within the accumulator which acts much like a shock absorber on a car. The result is the dampening of pressure pulses or surges and smooth operation of the system. Obviously, if an accumulator is over-charged, dampening will be less effective. On the other hand, if the pressurized air or gas in an accumulator leaks out, no dampening action will result and the entire hydraulic system will be subjected to overstress. Burst tubing, blown seals and jammed parts are some of the results that can be expected.

The connection between by-the-book maintenance and inspections and the single problem—loss of hydraulic fluid—now becomes more clear. Why, for example, is chafing of lines a predominent problem?

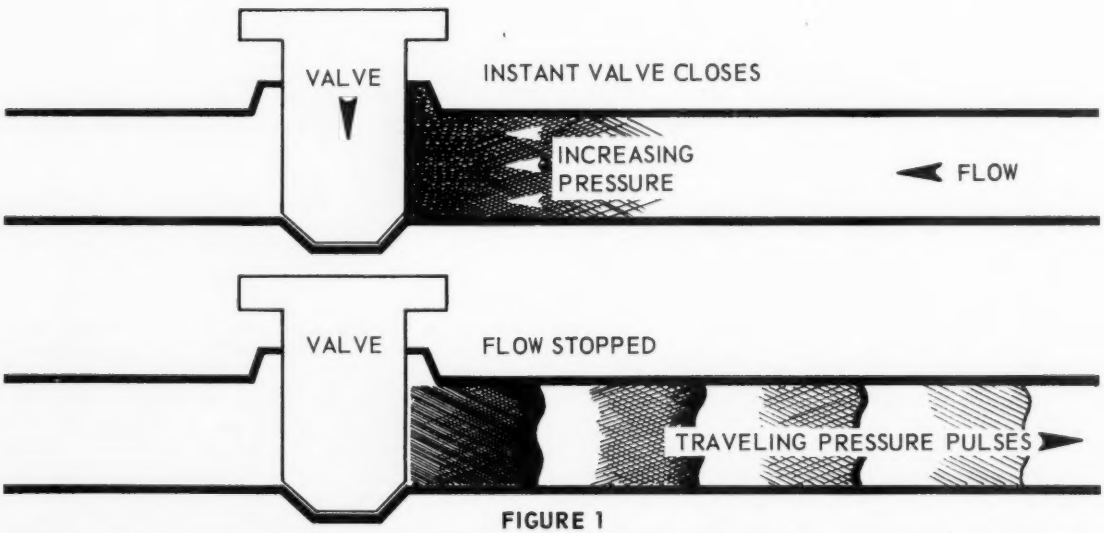


FIGURE 1

Pressure builds up the instant valve closes (shown at top) and is followed by pressure pulses reflected through system (lower diagram)

Is it possible that in every instance mechanics failed to properly route and anchor hydraulic tubing? Even the least experienced mechanic has been taught this universal procedure and understands its importance. The fact is that even when lines are properly routed and secured, chafing can eventually occur because of the severe vibration or "chatter" that is constantly present when the system is in operation. In time, flex hoses may stretch and standoff clamps may loosen or move. This means that good maintenance must always be reinforced by thorough inspections to ensure the integrity of the system.

When cursory inspections are coupled with poor maintenance practices, the likelihood of failures greatly increases. In one instance, a mechanic inadvertently installed a hose that was slightly longer than the one required. Although the line was properly installed, it was only a short time before system surges caused it to chafe and fail. However, despite the initial error, failure of the line could still have been prevented had proper and timely by-the-book inspections been performed.

As important as inspections may be for preventing lines from chafing, they are indispensable for precluding mishaps caused by failure of fittings and tubing. A chafed hose can be spotted and replaced; an improperly torqued fitting or line, however, cannot be detected until it develops symptoms. These usually show up in the form of leaks or cracks. But until symptoms manifest themselves, we have no way of knowing that a problem exists. Again this points to the need for correctly performed maintenance and inspections. If we fail to tighten a line or fitting sufficiently, we can almost be certain a leak will develop at some future date—even if the system is pressurized and operationally checked. The constant pounding from pressure surges will see to that. On the other hand, if we overtorque a fitting or line, we can expect cracks to develop or the component to suddenly fail. The best we can hope for is that cracks will develop first and be noted during inspection before failure can occur.

The same thing applies to seals. If they are improperly installed or damaged during installation, they may function normally without leaking when the system is operationally checked. Further, they may continue to do their job for weeks or months. But, as with improperly torqued fittings and lines, chances are good they will leak or fail without warning sometime in the future. The reason, again, is the same: the severe stresses constantly present within the hydraulic system during operation.

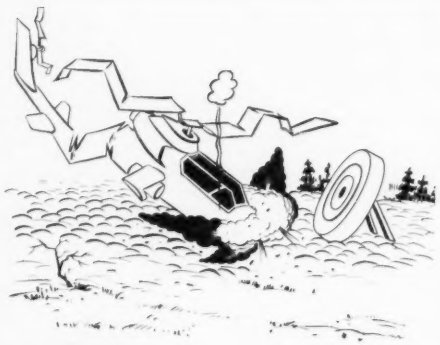
In addition, we often compound poor initial maintenance practices with poor followup maintenance. When we note a leaking line, for example, our usual reaction is to tighten it. If this stops the leak, we are satisfied and go our merry way. If the line was initially loose, we may have corrected the problem. However, if the line was properly torqued to begin with, we not only failed to correct the problem but added one of overtorque, setting the stage for an almost certain failure.

Similarly, our inspection habits often leave much to be desired. We may make a fairly thorough inspection of all tubing, fittings and components and find no chafed lines, leaks or cracks. Everything may appear to be in order. Yet, we may have either overlooked or discounted as unimportant small nicks, crimps or distortions in tubing. Each of these conditions recently was the cause of a precautionary landing, and all three mishaps resulted from loss of hydraulic fluid because of failed tubing. In each instance, failure occurred where the tubing had been damaged. One line had been nicked by a tool; another had been crimped during local manufacture; and the third had been stepped on, probably during the course of maintenance. Obviously, any defect, no matter how small, should never be considered insignificant. Stresses from normal system pressure, coupled with those caused by vibration and pressure pulses always present within the system, tend to concentrate at a weak point of a component, ultimately causing it to fail.

Why by-the-book maintenance and inspection? The reason is obvious. When we understand the unseen that goes on within a system, we also better understand the need for properly conducted maintenance and inspection. And we have considered only the loss of hydraulic fluid—a single problem in a single system. After noting the number of systems and subsystems found on Army aircraft, each with its own set of problems, we can rest assured that correct maintenance and inspection are absolutely essential for both successful mission accomplishment and safety. Granted, we may not always know why a particular procedure is specified in a TM, but we can rest assured there is a good reason and we should strictly follow that procedure.

As far as the hydraulic system and loss of fluid is concerned, we can readily see that not only must we properly maintain and inspect the various lines, hoses, fittings and other components but also ensure the entire system, particularly the accumulator, is properly serviced. Failure to do our job in this area can cause failure of one or more of the various system components even though they have been properly installed and maintained. The incessant chitter-chatter inherent to any hydraulic system, along with its potential to do damage, cannot be eliminated. It is there to stay—unless, of course, the reservoir runs dry. It will stop then. But so will a lot of other things. Don't let them.

briefs that teach



crash one

An AH-1G gunnery instructor pilot (IP) had made several firing runs during the day and night with different aviators. At 2330, he picked up another pilot and they proceeded to the holding area. Receiving clearance from range control, the IP took the controls and moved the aircraft to what he believed was the start fire line at about 100 to 200 feet agl. The aircraft's excessive altitude for hover fire was noted by range control personnel. Range control told the IP to descend to a low hover and that they were "cleared to go hot across the start fire line." The IP acknowledged the instructions and began a descent.

During the descent the crew engaged the target downrange and when the last rockets of the second set of four pairs were fired, the aircraft crashed and came to rest on its left side. Pilot and IP exited.

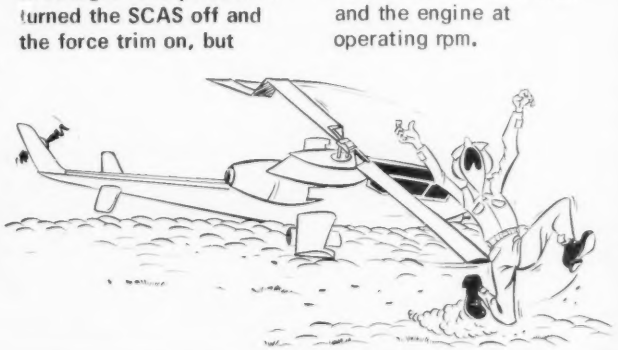
This crew was hurriedly maneuvering their aircraft to complete their last firing and get home. Crews were overtaxed to complete their familiarization firing, and the IP, who was not properly certified, had already flown several missions that day and night. This accident set the stage for . . .

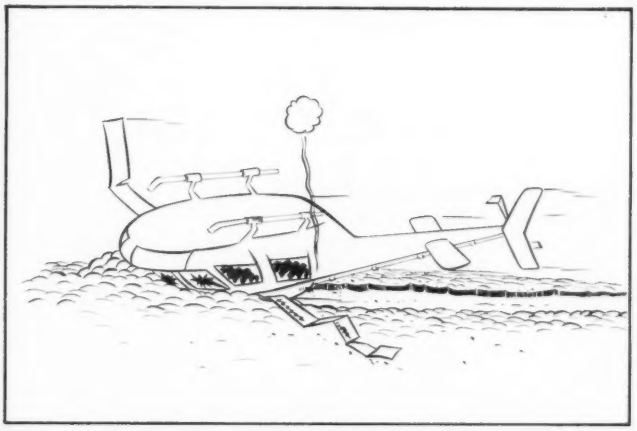
crash two

When crash one occurred, a "cease fire" and "aircraft on fire" call was transmitted by another IP. Hearing these transmissions, an AH-1G pilot and copilot who had just returned from a firing pass flew toward the downed aircraft. As they approached, the pilot directed his landing light on the aircraft and saw no movement. The canopy appeared to be intact. The pilot, thinking the crew had not exited the burning aircraft, tried to get to the downed aircraft before the fire spread to the cockpit. He told his copilot to get their fire extinguisher and go to the aircraft as soon as they landed.

As the aircraft touched down, the copilot ran toward the burning wreckage. **The pilot then turned the SCAS off and the force trim on, but left the throttle in the full open position. He got out and ran a short distance toward the downed aircraft.** Realizing he might need his sheath knife to break the other crew out of their canopy, he returned to his aircraft. As he looked up at the canopy, the aircraft pitched forward and rolled to the right toward him. As it rolled, he ran away from the aircraft. Both main rotor blades struck the ground and the aircraft came to rest almost inverted. The pilot was struck in the shoulder by flying objects and sustained a broken collarbone.

Although this pilot is to be commended for his efforts to assist the downed crew, in his haste he left his aircraft with controls unsecured and the engine at operating rpm.





see no evil, hear no evil

An OH-58 IP was administering an aviator-in-command flight evaluation to another pilot. Entering the traffic pattern, the IP received clearance from the tower to shoot a straight-in autorotation. After completion of this maneuver, the IP was given clearance to make a low-level autorotation and the pilot aligned the aircraft on the final approach heading at an altitude of approximately 50 feet agl, maintaining 80 knots indicated airspeed.

At about 10 feet agl, the pilot applied initial collective pitch and attempted to level the aircraft. A witness stated that the aircraft was not completely leveled and a higher than normal coning angle was present in the main rotor blades at this point. At about 1 to 2 feet agl, the pilot applied additional collective to cushion the aircraft onto the runway. At this point, both aviators noticed that the apparent ground speed of the aircraft was faster than normal, and that the main rotor rpm had decayed to between 205 and 210. The aircraft touched down hard and came to a stop in an upright position after skidding 87 feet.

During the low-level autorotation, the pilot allowed the main rotor rpm to decay below the minimum prescribed for autorotative maneuvers (225 rpm). **The IP failed to recognize the critical situation and take corrective action.** The aircraft touched down with a forward ground speed in excess of the maximum of 5 knots. An MWO to install a low rpm warning system in the aircraft had not been complied with although the warning system had been available for more than 50 days before the accident.

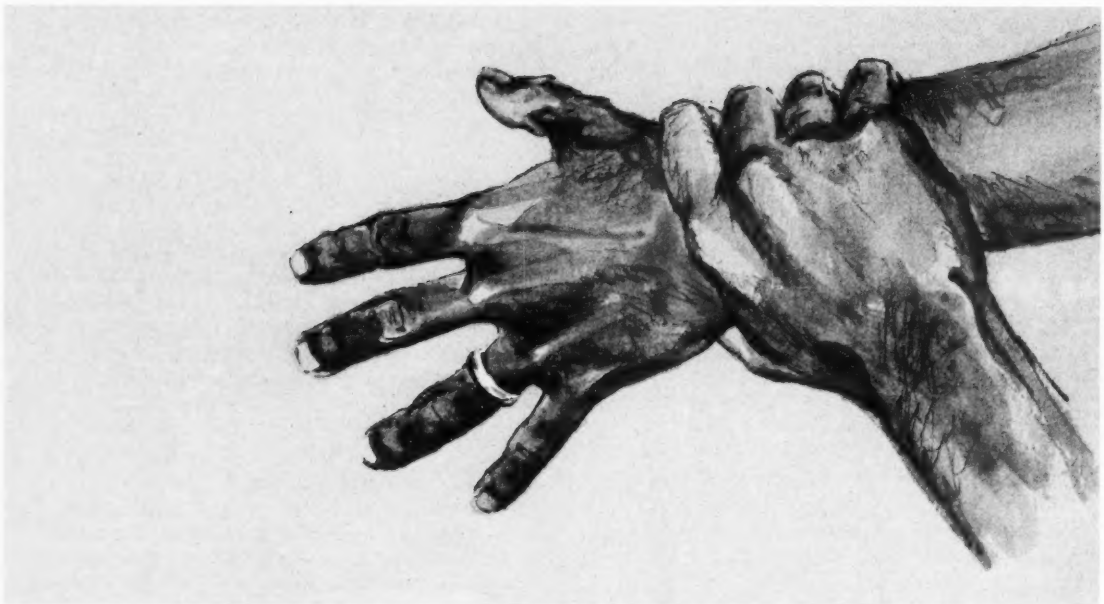
lest we forget

A U-8D pilot arranged for a proficiency flight for himself and picked up his copilot and passenger in front of flight operations. The pilot told the copilot that the proficiency flight would consist of normal takeoffs and landings in closed traffic. The crew briefing consisted of the pilot requesting that the copilot monitor the gauges during takeoff and get the gear on command.

Two uneventful trips were made around the traffic pattern. After the third takeoff and on downwind leg abeam the intended touchdown point, the pilot called for the before-landing check. As the checklist was started the tower advised that they were number two for landing to follow a Cessna 172 on 5-mile final. Both pilots looked for the Cessna but were unable to locate it. After this interruption, the crew did not complete the before-landing checklist. The pilot elected to extend his downwind leg to allow spacing between them and the Cessna.

When they were on very short final the pilot requested a gear check at the same time the tower cleared them to land. The copilot said he instantly replied "down" without any visual check being accomplished since his attention was focused on turning his selector switch to acknowledge the tower. While on base and final, both the pilot and copilot were preoccupied with the Cessna's position. **This lack of flight discipline allowed their attention to be distracted from the job of flying and they landed the aircraft gear up.**

JEWELRY & MACHINES



DEAR ABBY

IT'S WORTH REPRINTING

Dear Abby: I am the plant manager of a large industrial company employing more than 3,000 men, and their safety is my concern.

Enclosed is a letter that, I am told, appeared in your column about 10 years ago. How much would you charge us to reprint this letter in our company paper? It could prevent accidents and perhaps save lives.

CHICAGOAN

"Dear Abby: I am one of those foolish wives who insisted that my husband wear his wedding ring at all times. My husband is a maintenance mechanic, and this is what happened. Yesterday, I received a call informing me that my husband was at the hospital! While jumping off a construction truck, he caught his ring on a piece of metal, and his finger was practically torn off. I was told he was lucky he wasn't killed since he lost his balance and fell under the wheels of the truck.

"Abby, please print this in your column as a warning to other women who want their husbands to wear their wedding rings to work."

AL'S WIFE

"Dear Wife: Thank you for your letter and while we're on the subject, read this one:

"Dear Abby: When my husband and I were married we had a double-ring ceremony, and he promised he would never take his wedding ring off. And he never did. After a few years he gained a little weight and couldn't get it off. My husband was an electrician.

"Well, to make a long and very tragic story short, his wedding ring wore a tiny hole through his in-

sulated glove and a fatal contact was made. He died instantly. When his lifeless body was examined, the only sign of injury was a small burn where his wedding ring encircled his finger."

ELECTRICIAN'S WIDOW

"So . . . dear wife, if your husband works around machines or electricity, tell him to leave all rings at home—if you really love him, that is.

"Rings and other types of jewelry for women and men working with machinery and electricity are a major problem in industry. Sentiment is a poor excuse for wearing a ring when it can cause the loss of a finger, hand, arm or even a life."

Dear Chicagoan: Be my guest. No charge. (P.S. And the same goes for any other company that would find it useful.)

BUFFALO COURIER-EXPRESS, Sunday, July 20, 1975

We receive inquiries from people throughout CONUS about wearing jewelry while performing maintenance on and around aircraft and shop electrical equipment. USAAAVS teams returning from assistance visits report that, in most cases, only the FOD portion of the unit SOP mentions jewelry.

Wearing rings, watches, ID bracelets and tags can be dangerous for people who work with their hands. Jewelry can snag on protruding parts, and metal jewelry and neck chains make excellent electrical conductors.

Although there is not, in black and white, a statement "Thou shalt not wear rings and other type jewelry when performing maintenance on electrical systems and equipment" (except for a draft TB), there are enough references that indicate that personnel should not wear jewelry when working under these conditions.

• AR 420-90, Fire Prevention and Protection, basically states that in the absence of specific DA instructions, technical manuals or regulations, National Fire Protection Association or other nationally recognized fire protection codes will be used.

• Change 20 to TM 55-1500-204-25/1, chapter 7, par. 7-8, page 7-1, states: " . . . safety engineers and safety officers will insure that proper safety procedures are adhered to in accordance with AR 385-10, Army Safety Program; AR 385-30, Safety Color Code Markings and Sights; AR 385-32, Protective Clothing and Equipment; The Occupational Safety and Health Act of 1971; all applicable fire codes; and other accepted civilian and military safety practices."

• The National Fire Code (NFC), Vol. 14 (1975), states: "Finger rings, watches, chains, etc., should not be worn while working near battery terminals because a short circuit may cause an arc and result in a severe burn."

• The National Safety Council's Supervisors Safety Manual (3rd Edition, 1972) says that **any type** of jewelry is out of place in any specific shop. Fingers can be lost or other serious injury could be caused. Any metal jewelry around electrical equipment can be dangerous.

• TB 385-4 (draft), Safety Precautions for Maintenance of Electrical/Electronic Equipment, requires personnel "to remove personal bracelets, watches, rings or metal objects before performing maintenance on electrical equipment."

So, as you can see by the above references, there is more than enough material to use in your unit's safety SOP to require that jewelry of any type not be worn while working around aircraft and shop equipment.

USAAAVS **Sergeant First Class Jerry E. Mills**
Directorate for Aircraft Accident Analysis and Investigation, U.S. Army Agency for Aviation Safety

The owner of this hand was preflighting a helicopter when he slipped and fell. His wedding band caught on a projecting piece of metal and dug into his flesh.

PEARL'S

Personal Equipment & Rescue/Survival Lowdown

Wearing of Undergarments

The latest in men's fashionable underpinnings may be stylish and contemporary, but it is also potentially hazardous to an aircrew's health. We're referring to the nylon and other slick fabric underwear that's on the market. These items should never be worn under your Nomex flight suit. The reason: Nylon and other similar artificial fibers melt at about 300 to 400 degrees F. The Nomex will protect you against the heat and delay the heat transfer, but sufficient exposure soon raises the skin side temperature to 300 to 400 degrees F. The artificial fiber then starts melting and severe burns result as the molten material sticks to the skin. So—a word to the wise! Save those racing silks for after the flight!—*HQ AFSC Safety Management Newsletter*

Mishap data files indicate individual aircrewmembers have received severe thermal injuries during post-crash fires while wearing nylon/orlon type synthetic undergarments. The thermal injuries have been attributed to heat transfer through the Nomex flight clothing and the low melting point of the nylon undergarments. USAAAVS has one mishap on record where the aviator was wearing a nylon/orlon batted thermal underwear. The Nomex uniform provided protection from the fire, but the individual received fatal burns because the underwear melted. USAAAVS recommends only the cotton/wool clothing listed in Common Table of Allowances 50-900, dated November 1973, be worn by aviation personnel.

Nomex Headshield

I have come across a very interesting item of personal protective clothing that warrants a closer examination by more qualified personnel than I in the field of thermal injury protection.

This piece of clothing is a Nomex headshield manufactured by Racemark, of Rallston Lake, New York, and is more commonly seen being worn by race car drivers. Its protection seems to fill the gap that current issue Nomex items leave in the area of the lower face and neck.

I have been forbidden to wear the headshield because it is not an Army issue item. I have worn the headshield on two occasions and found that it did not hinder the wearing of the SPH-4 helmet, but actually enhanced the hearing protection and, obviously, the additional thermal injury protection.

A garment similar in design to the headshield manufactured by Racemark was evaluated by the U. S. Army Aeromedical Research Laboratory. Their conclusions were that any item which would break the SPH-4 ear cup seal would reduce the sound protection. The garment was also uncomfortable to wear in warm climates. Nomex does not readily absorb moisture and, therefore, offers no cooling by evaporation.

Since incorporation of the crashworthy fuel system (CWFS), there have been no thermal injuries or fatalities in survivable accidents in aircraft equipped with the CWFS. In the past four years, there has been one minor thermal injury in a UH-1H without the CWFS and one minor thermal injury in a U-10A without the CWFS.

For these reasons, it is the opinion of USAAAVS that the Nomex headshield would have limited application in the Army aviation community.

Signal Kits, Personnel Distress

The SRU-21/P survival vest and the new OV-1 aviator survival vest are being issued with the Signal Kit, Personnel Distress Foliage Penetrating, Red, Model No. 201 Global, NSN 1370-00-490-7362. This signal kit is not available to Army users for replenishment or training. The Signal Kit Item Manager at ARCOM (U. S. Army Armament Command) advises that action is presently being taken to adopt the Model 201 as Standard A to replace the current Signal Kit, Personnel Distress, Red M185, NSN 1370-00-921-6172, listed in chapter 2, SB 700-20. Recommend all users take action to conserve the Model 201 for actual emergency use. Training and replenishment needs can be satisfied by ordering the Model 185.—*Aviation Life Support Systems Manager, ATTN: AMSAV-WL, U. S. Army Aviation Systems Command, P. O. Box 209, St. Louis, MO 63166, AUTOVON 698-3241/3291.*

If you have a question about personal equipment or rescue/ survival gear, write Pearl, USAAAVS, Ft. Rucker, AL 36362

USAASO Sez

Look Out For The "T"!

WHEN IS A SID not a SID? When it's a "T." That "T" in a blue triangle in the remarks section of some approach plates doesn't mean bring your clubs anymore than the "A" in the triangle means a good RON spot.

In an informal survey of aviators representing a broad spectrum of experience, the answer was to disregard the "T" as not applying to "Army aviators," although AR 95-1 (para 4-25) says it will be considered. Only a few knew that the "T" means there are obstructions or required flight track restrictions in the departure area.

Fewer realized that higher takeoff minimums are applied (mandatory for civil users) so that the obstructions may be seen and avoided during the IFR departure. A small number of the aviators interviewed knew that obstruction avoidance procedures are seldom included in IFR clearances from controlled civil airports and almost never from uncontrolled airports. The question is, are we using an excellent safety tool or are we passing over the "T" when presented because our regulations allow departure from zero-zero to 200 feet and one-half mile visibility depending on qualifications?

What's the solution? Located behind the nonstandard alternate minimums in the low altitude books and in the interim MAN is a tabular listing of all aerodromes that are marked with a "T" in the approach books. This information is also supported by the FAA NOTAM system as well as part 3A of the FAA AIM. Although we can legally disregard the numbers applying to T.O. minimums, the verbiage on initial departure routings or SID references should be considered in takeoff planning. If no specific information is shown and you exercise your lower minimums for takeoff, it might be wise to check with the local folks on what's out there in the smog that caused the "T" to be placed on the plate.

A quick glance through any of the IAP booklets illustrates the value of using this information. Phraseology such as *immediate* climbing left turn to 3400, or climb to MEA in holding pattern more often than not indicates there is something more in the airspace than air.

Each pilot, prior to departing an airport on an IFR flight, should consider the type of terrain and other obstructions on or in the vicinity of the departure airport and take the following actions:

- Determine whether a departure procedure has been established for obstruction avoidance.
- Determine if obstruction avoidance can be maintained visually or that the departure procedure should be followed.
- At airports where instrument approach procedures have not been established, hence no departure procedure, determine for himself what action will be necessary and take such action that will assure a safe departure.

USAASO Sez—Good flight planning includes a review of the *approach plate* and *takeoff data* for the *departure field!*

ACRONYMS USED

AIM:	Airman's Information Manual	MAN:	Military Aviation Notice
FAA:	Federal Aviation Administration	MEA:	minimum enroute altitude
IAP:	instrument approach procedures	NOTAM:	notice to airmen
IFR:	instrument flight rules	RON:	remain overnight

SID: standard instrument departure

Major O. Glenn Goodhand

Brigadier General O. Glenn Goodhand

ARMY AVIATION HALL OF FAME

MAJOR O. Glenn Goodhand was prominent in expanding the role of Army aviation in World War II. He had more than 500 hours of combat flying and improvised unique and effective aerial tactics in the European battle areas.

At Cassino, on his own initiative, he conducted experimental pioneer work in night flying with Cub-type aircraft, devised feasible methods of adjusting long range artillery fire at night and flew night missions, often deep behind enemy lines.

At Anzio, Captain Goodhand developed a system for Corps Artillery aircraft which assured continuous target coverage, engagement by the most appropriate artillery and early pilot warnings of hostile fighter aircraft. The latter action greatly enhanced artillery effectiveness and pilot safety.

In Southern France, Major Goodhand organized a V Corps unit of L-5 aircraft for observation ahead of advancing ground elements. This unit developed and employed original techniques for direction of P-47 fighter-bombers on targets beyond artillery range.

His organization and operation of L-5s for reconnaissance and fighter-bomber direction was an outstanding benefit to V Corps, and unique for liaison type aircraft at that time.

After World War II, Major Goodhand implemented a National Guard Bureau program which rerated Navy and Air Force pilots as Army Liaison Pilots for Army National Guard vacancies. This program later served as a primary source of Army aviators for the Korean War.

Major Goodhand entered Army pilot training in August 1942. He was retired as a Brigadier General and Master Army Aviator in May 1964.

AFTER SUNSET

THIS ISSUE of the *DIGEST*, and next month's, examine evolving concepts of how Army aviation will fight on a high threat battlefield, *After Sunset!*

Night combat operations are assured in any future conflict. Preparations now are being made for this at the U. S. Army Aviation Center at Ft. Rucker. There are others—as these two issues point out—who also are developing both hardware and tactics and are training for night combat operations.

CW2 Dave Heaton's article (page 1), "Night Hawk Training Test," provides an indepth look into the highly successful, three-phase program developed at the Aviation Center. Other articles in the 2-month series cover activities of tactical units, and still more discuss hardware developments.

It would appear that after Night Hawk—night combat training at the Aviation Center—there are two roads to follow: (1) operational unit training without night vision devices and (2) night combat training aided by night vision devices. We must travel *both* roads!

Army aviators *first* must be trained, both at Ft. Rucker and in the field, to conduct sustained night operations without night vision aids. Then, they must be trained to use night vision aids while flying in combat. To travel both roads successfully, the Aviation Center tactical units and the research and development community must continue to work closely together. There must be abundant and frequent exchanges of information and lessons learned.

This After Sunset series is aimed at promoting such a rapport.

Major General William J. Maddox Jr.
Commander, U.S. Army Aviation Center
Ft. Rucker